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THE MACKENZIE RIVER REGION

PHYSICAL FEATURES AND WONDERFUL NATURAL RESOURCES OF A COMPARATIVELY UNKNOWN TERRITORY COMPRISING A FIFTH OF ALL CANADA

BY CHARLES CAMSELL

THE Mackenzie is one of the great rivers of the earth draining an area 682,000 square miles in extent or about one-fifth of the total area of Canada. More than one-third of its basin is still a "terra incognita" to the white man and is known only to a few small roving bands of Indians of the great Chipewyan stock. This in spite of the fact that it is 125 years since it was first descended to its mouth by that noted explorer, Alexander Mackenzie. It is, however, recently beginning to attract some attention in the commercial world among men who are willing to exploit its natural resources. The agricultural portion, namely, that within the basins of the Peace and Athabaska Rivers, has been widely advertised as "The Last West" and is being gradually opened up and settled. This portion of the Mackenzie Basin, together with that immediately to the north of it as far as the Liard River and Great Slave Lake, contains the largest area of unoccupied agricultural land in Canada and is the direction in which Canadian agricultural expansion is bound to take place. The remainder of the basin to the north and east is still largely unexplored and while never likely to support a large agricultural population offers a vast field of possibly great value to the prospector. What this portion of the basin contains in mineral resources it is impossible to say and unsafe to hazard a guess in view of the surprises we have already received in opening up similar country in Northern Ontario. It is satisfactory to note that the Canadian Geological Survey is now embarking on a scheme for the exploration of the vast tracts of unknown territory in this and adjoining portions of Northern Canada.

PHYSICAL FEATURES

The Mackenzie River carries to the Arctic Ocean the drainage of 682,000 square miles of the northwestern portion of Canada. Its basin includes the northern parts of the provinces of British Columbia, Alberta, and Saskatchewan, and the western part of the Northwest Territories, covering from north to south about 16 degrees of latitude, from 53° to 69°. All the varieties of great land forms of mountain, plain, and plateau are included within its boundaries.

The basin of the Mackenzie River comprises three main physiographic provinces. On the west is the great series of parallel mountain ranges known as the Rocky Mountain system, rising more or less abruptly to heights which in the south often attain 10,000 feet and on Mt. Robson reach 13,000 feet, but in the extreme north rarely exceed 5,000 feet. Many of the stronger tributaries of the Mackenzie cut deeply into these ranges and some, indeed, such as the Liard and Peace, cut right through them, drawing some of their water from the western or back slopes of the ranges. The eastern boundary of this mountain region is fairly definite though not a direct line. Starting from a point about the intersection of latitude 53° and longitude 116° the line runs northwestward crossing the

The Mackenzie River at the junction of Great Bear River, showing one of the fault blocks (Bear Rock) that rises out of the Mackenzie lowland

Peace River about Hudson's Hope and striking the Liard River near longitude 125°. Here there is a great bay in the mountains and their continuity is interrupted by the Liard River which cuts directly through them. Under the name of Mackenzie Mountains they spring up again, however, immediately north of that river, but their eastern front has now been stepped far to the eastward and abuts on the Liard River at Fort Liard as if they had been displaced by a great fault along the valley of Liard River. From here the line runs northward touching the Mackenzie River at the mouth of Nahanni River and continuing thence along the western side of Mackenzie River to latitude 65° 30′, where it turns in a broad curve and sweeps westward around the head waters of Peel River. The Mackenzie Mountains which are one of the largest blocks of the whole Rocky Mountain system die out in this region but another, lower, range springs up north of Peel River and extends down to the Arctic coast, its eastern front following closely the valley of Peel River and rising as an abrupt fault scarp out of the delta of Mackenzie River.

The mountain province at nearly all points merges gradually by a decrease of elevation and a flattening out of the surface into the lowland province which occupies the central portion of the Mackenzie Basin. This province is a

The Valley of Peace River at the junction of Smoky River

broad northward sloping lowland through which the Mackenzie flows gently to the Arctic. It is a country of lakes and muskegs and of meandering streams flowing in moderately shallow valleys. The evenness of its surface is only broken here and there by a few rounded wooded hills or ranges such as the Cariboo Mountains north of Fort Vermilion, the Horn Mountains west of Fort Simpson, and an unnamed range of hills which lies east of the Mackenzie from Fort Wrigley to Great Bear River.

The Mackenzie lowland is the northward extension of the Great Plains region of the central part of the North American continent. It occupies a position in the north similar to that to the south through which the Mississippi flows southward to the Gulf of Mexico. In contrast to the Mississippi region, however, the Mackenzie lowland is forested to its mouth and it embraces within its limits three of the largest lakes on the continent.

The eastern province of the Mackenzie Basin is part of the great Laurentian plateau which occupies such a large part of northern and eastern Canada and almost completely encircles the great inland sea of Hudson Bay. The western boundary of this region is not sharply defined topographically but it coincides with the eastern border of the Paleozoic rocks which underlie the lowland region. It is a country of numerous lakes and of rivers flowing in ill-defined and shallow valleys. On a broad view its surface is level or rolling but in detail it is rugged, broken and rocky with little or no surface veneer of soil or loose material to cover the inequalities of the bed-rock. Its northern portion is treeless and is known as the Barren Lands.

The physical features of the Mackenzie Basin then are these: A mountainous highland on the west; a low-lying, rugged, rocky and partly treeless plateau on the east; and in the middle a broad, almost level, forested lowland with the trunk stream like a great artery flowing northward to the Arctic Sea, fed on one hand from the melting snows of the mountains and on the other hand from the numberless lakes of the plateau region on the east.

The Mackenzie ranks as one of the eight great rivers of the earth. Its length is reckoned at about 2,800 miles to the head of Peace River and its volume has been estimated to be about half a million cubic feet per second. It is exceeded on this continent only by the Mississippi in length, volume and drainage area, but it is greater in length and drainage area than the St. Lawrence.

It is a magnificent natural waterway allowing steamers of 5 feet draft to ascend without interruption from the Arctic Ocean 1,400 miles to the rapids on Slave River at Fort Smith. Above this it is navigable again for lighter draft steamers on the Peace and Athabaska Rivers for a total length of about 1,500 miles in three sections. Including its great lakes and those tributary streams which have already been explored it has a total length of navigable river and lake shore line of nearly 7,000 miles, interrupted, however, at three points, namely, the 16 miles of rapids on Slave River at Fort Smith, the rapids and falls on Peace River below Vermilion, one mile in length, and the 90 miles of rapids on Athabaska River above Fort McMurray.

The Ramparts of Mackenzie River, where the river cuts through vertical cliffs of Devonian limestone

The following table presents the details of these navigable waterways, the distances being in round numbers:

NAVIGABLE WATERS OF MACKENZIE BASIN

	Miles
Lower Mackenzie River section:	
Mackenzie River, below Great Slave Lake	1,000
Peel River, to mouth of Wind River	250
Great Bear River	90
Shore line, Great Bear Lake	1,360
Liard River	440
Shore line, Great Slave Lake	1,440
Slave River, Great Slave Lake to Fort Smith	200
Total	4,780
Athabaska Lake section:	
Slave River, Athabaska Lake to Smith Landing	100
Peace River, Slave River to Vermilion Falls	220
Shore line, Athabaska Lake	560
Athabaska River, Athabaska Lake to McMurray	170
Clearwater River	80
Total	1,130
Peace River section:	
Peace River, Hudson's Hope to Vermilion Falls	550
Athabaska River section:	
Athabaska River, Grand Rapids to McLeod River	325
Lesser Slave River and Lake	115
Total	440
Total for whole Mackenzie Basin	6,900

Steamers ply on all four sections of the waterways of the Mackenzie Basin, but, as they are operated solely for the benefit of the fur-trading companies and the missions, they merely follow the main routes, which are the Peace, Athabaska and Mackenzie Rivers. Some of these steamers are equipped with passenger accommodation and it is possible for travellers to make the journey in comfort from the end of the railway line at Athabaska to the head of the delta and return by securing a passage from one of the fur-trading companies.

The season of navigation extends over about four months and in the southern portion of the region, namely, on the Peace and Athabaska Rivers, it is somewhat longer.

The falls of Peace River

These waterways are destined to become more and more important as settlement and development of the country advance because, as they have been in the past, so will they continue to be in the future the main highways on which the commerce of the country must be carried. Railways will supersede them to a certain extent, but only in the southern half of the region will they be likely to do so where the population will be mainly a farming population. Farther north where no industries are likely to develop that requires a large resident population the waterways will continue to be the lines of trade and transportation for years to come.

NATURAL RESOURCES

The natural resources of the Mackenzie River region include minerals, furs, timber, game and fish, and agricultural land.

To appreciate its possibilities in mineral wealth it is necessary to have some idea of the rock formations which comprise the geology of the region.

The eastern portion of the basin is covered by very ancient rocks of pre-Cambrian age. In this region are large bodies of granite or gneiss that have been intruded into older sediments and volcanic rocks of Keewatin and Huronian age of which only remnants are now left here and there in the granite batholiths. On this complex of igneous and sedimentary rocks rest patches of what are probably Keweenawan rocks.

The mountains on the western border of the basin are built up mainly of Paleozoic sediments which have been thrown by compression into a series of parallel ranges striking in a general northwesterly direction.

The lowland portion in the centre consists of flat-lying or gently undulating beds of limestones and shales of Devonian age, which are covered in the southern portion of the basin by a thick sheet

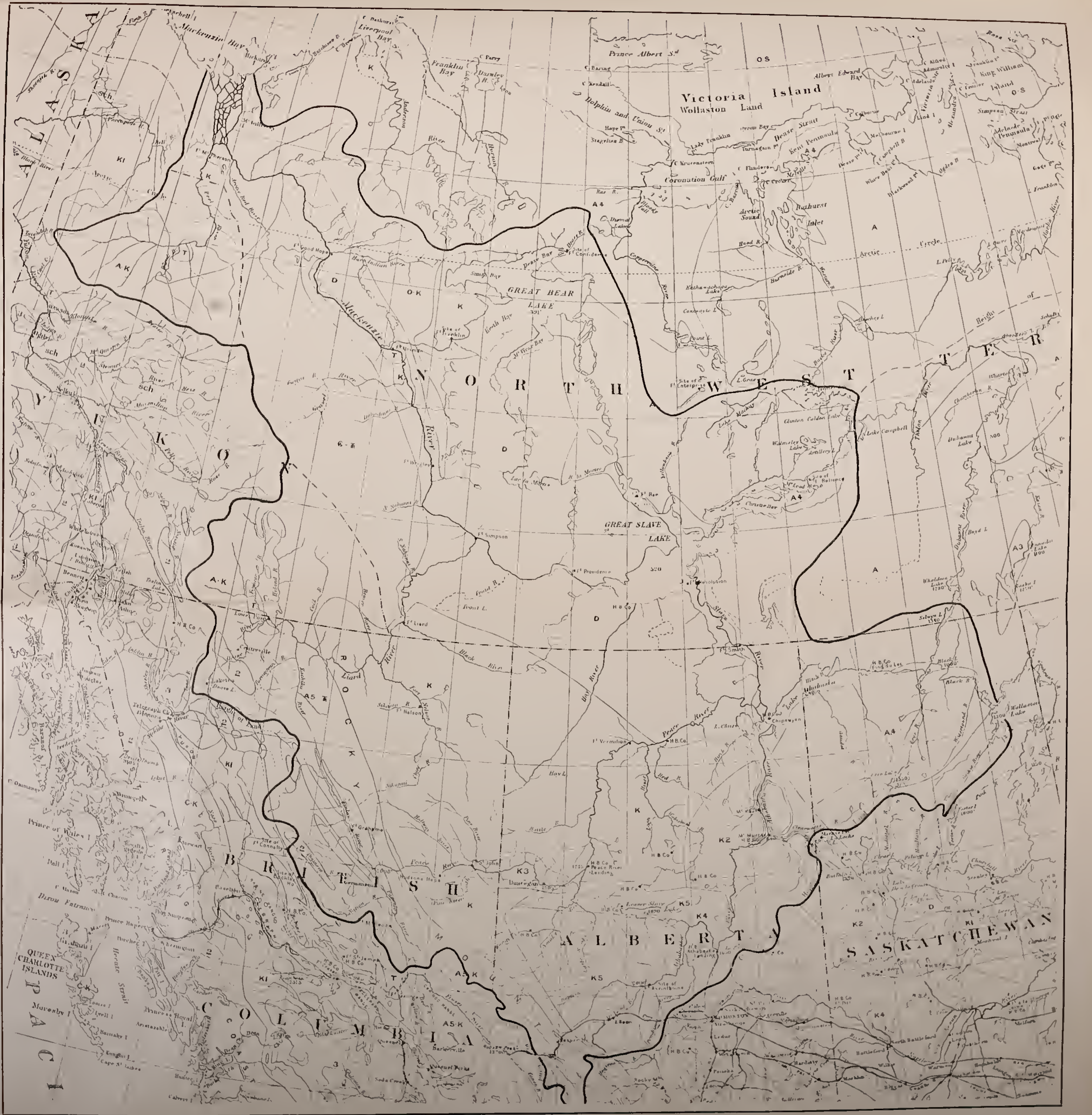
The Mackenzie River, a mile and a quarter wide at old Fort Wrigley

of Cretaceous sandstones and shales. Patches of Cretaceous rocks and smaller areas of Tertiary also rest on the Devonian floor in several places in the northern part of the basin.

The pre-Cambrian rocks of the east are known to contain iron, copper, nickel, and gold, but little is known of them beyond their actual occurrence in place and in no case has there been as yet any production of these metals. Iron ore occurs on the islands both of Great Bear and Great Slave Lakes. Copper ore is known at several points, but probably the most important locality is to the north and east of Great Bear Lake where it occurs in the native state in rocks similar to those on the south shore of Lake Superior. Evidences of nickel occurring under conditions similar to those at Sudbury, Ontario, have recently been discovered at the east end of Athabaska Lake. Gold ores are known in several places in quartz veins in the older pre-Cambrian sediments where they are cut by the Laurentian batholiths.

The pre-Cambrian of the eastern part of the Mackenzie Basin and of the region eastward to Hudson Bay is still virtually unexplored and these rocks comprise the largest area of unprospected ground on the North American continent. Elsewhere rocks of this age and character contain some of the greatest copper, iron, nickel, silver and gold mines of the world and it is not unreasonable to suppose that similar deposits will be found in this vast northern region.

The mountainous, western portion of the Mackenzie Basin, because it is made up mainly of sedimentary rocks, has not



THE MACKENZIE RIVER REGION

Fond du Lac on Athabaska Lake, a typical northern fur trading post

the variety of metallic minerals that are found in the east. Coal occurs at several points on the eastern edge of this portion of the basin in rocks of Cretaceous age, and beds of salt and gypsum in some of the older rocks. Where, however, such tributaries of the Mackenzie as the Peace and Liard cut far enough back into the heart of the ranges to reach a region in which igneous intrusion has been active there again evidences are found of gold, silver, copper and lead ores. The Omenica district of the Peace River and the Cassiar district of the upper Liard have each produced placer gold amounting to several millions of dollars, and it is quite possible that in the great unprospected region north of the Liard River gold fields, if not as great, but of considerable importance, may yet be found. Of this there is already some evidence.

The lowland portion of the basin because of its being underlain by almost undisturbed rocks of a sedimentary nature is not likely to be rich in metallic minerals. It does, however, contain such non-metallic minerals as coal, salt, gypsum, oil and gas, and the metallic minerals, lead and zinc.

Coal occurs in abundance in the Cretaceous rocks of the Athabaska, Peace, and Nelson Rivers, and to a less extent in the Tertiary. Two of the Tertiary coal fields, namely, one at the mouth of Great Bear River and another on Peel River, are on fire and have been burning at least since Alexander Mackenzie descended the river in 1789. The fire is probably due to natural causes in spite of the Indian story that it was started by a legendary hero of theirs in order to cook his dinner of beaver.

Salt and gypsum are associated together at a number of points in Devonian rocks. Brine springs situated west of Fort Smith are the source of all the salt used in that northern country, while other brine springs and outcrops of rock salt occur at several other points, notably in the neighborhood of Fort Norman.

The most important mineral products

of the lowland portion of the basin, however, and possibly of the whole of this portion of Canada are oil and gas, evidences of which are found from the height of land on the south to the Arctic Ocean on the north. The original source of both these substances is believed to be in the Devonian rocks and since these rocks cover about half of the total area of the whole Mackenzie Basin the possibility of discovering oil pools of importance in this region is excellent. Gas has been proven in great quantity by several drill holes, but little intelligent effort has so far been directed to the search for oil. Some drilling has been done on the Athabaska River but sites for the drill holes have more often been determined by the suitability of the ground for camps rather than by a study of the rock structure. The result has consequently been disappointing.

A lake trout from one of the great lakes of the Mackenzie Basin

The fisheries of the great lakes of the Mackenzie, namely, those of Athabaska, Great Slave, and Great Bear Lakes, are among the most valuable of the assets of the region. Whitefish and lake trout are the principal fishes, and although fish is the principal food of the majority of the population and hundreds of thousands of pounds weight are consumed annually, this amount is so small in proportion to the quantity these lakes must contain that there is no evidence that they are being exhausted. Fisheries are made annually on Athabaska and Great Slave Lakes, but Great Bear Lake which contains the finest quality and the greatest variety of fishes, is virtually untouched. Whitefish in this lake go up to 12 pounds in weight, and trout to 50 or 60 pounds.

The fur trade is at present the most important industry in the Mackenzie Basin and with the exception of the farming and ranching communities in the extreme southwest of the basin virtually the whole population is more or less directly interested in this business. The history of the region is intimately bound up with the operations of the fur traders; and the few scattered settlements that are situated at intervals of 100 to 200 miles along the valley of the main rivers were originally established and are still maintained for the purpose of trading furs with the natives. Nearly all the different kinds of high grade furs such as fox, sable, mink, marten, ermine, lynx, beaver, otter, are obtained in the region, and the Hudson Bay Company, probably the greatest fur-trading company in the world, obtains the greater part of its furs from here. Canada exports over five million dollars' worth of furs annually and of this amount the Mackenzie Basin supplies probably one-third.

Of the agricultural possibilities of the region few people yet have any idea whatever, though the public is beginning to awake to the value of the land within the basins of the Peace and Athabaska Rivers, and railway lines are being built into this region with the object of settling it up. There is also a vast area north of the Peace River as far as Great Slave Lake and the Liard River of which we know little, though sufficient

Devonian limestone, underlying the lowland portion of the Mackenzie Basin. The limestone is here directly overlaid by the Tar sands of the Cretaceons

to prove that it is suitable for agricultural purposes. Altogether there is in this southwestern portion of the Mackenzie Basin an area of about 200,000 square miles suitable for settlement and there are no climatic or other reasons why a self-supporting population amounting to some millions may not live and thrive there on the products of agriculture. This whole region more than any other is the direction in which Canadian expansion in agricultural pursuits is bound to take place.

Forest products might be mentioned as another of the natural resources of the Mackenzie Basin. The whole of the basin down to the Arctic coast is thickly wooded with the exception of the northeastern border which is included in the so-called Barren Lands. The principal trees are spruce, tamarack, banksian pine, birch, and poplar. One of the uses to which these trees will eventually be put will be for the manufacture of pulp. The spruce, however, is a useful tree for lumber and it grows to sizes suitable for this purpose on the banks of all the streams even as far north as the delta of the river. Large areas have been burnt and the timber destroyed by the natives because they say that it improves the hunting. Forestry protection, however, is being undertaken by the Government and the effects of this are already noticeable in the decreasing number of forest fires.

The natural resources of the Mackenzie Basin are sufficient evidence that its future is assured, for there are no difficulties, climatic or topographic, such as to prevent men of means and enterprise from entering and remaining in the country to develop these natural resources. Settlement of course must begin at the south and progess northward until the limit is reached. The northern limit for the settlement of an agricultural population in any great numbers will probably be about latitude 62° north, but there are no doubt numbers of chances for mining communities to spring up north of this and in the less hospitable country that forms the rocky region along the eastern edge of the Mackenzie Basin.

COMMERCIAL GLUCOSE AND ITS USES

A MUCH MISUNDERSTOOD AND MALIGNED PRODUCT—NECESSARY FOR CERTAIN FOOD STAPLES AND A GOOD SUBSTITUTE FOR MORE EXPENSIVE INGREDIENTS

BY GEORGE W. ROLFE

Most well-informed people know that in the early part of the last century Kirchoff was the first to describe a sugar made by boiling starch with dilute sulphuric acid, and that this sweet, subsequently found to be other than cane-sugar was called "glucose" or "grape-sugar." Later it was termed "dextrose" when in the progress of science it became necessary to distinguish the individual from a whole family of "glucoses" which had been discovered.

Nowadays, most of us have heard of "glucose" as a commercial product of doubtful reputation. People look askance when glucose is mentioned. Confectioners and grocers make haste to deny that glucose ever appears in their products. Glucose is classed with harmful food adulterants, and has been called by pure food experts the "champion adulterant" of all. It has even been depicted in cartoons as a devil with hoofs and horns. Glucose has also been called "mucilage," the implication being that it is only fit for postage-stamps and not for human stomachs. This may be why many associate glucose with glue. The names sound alike and both are sticky, but the reasoning is like assuming that all gentlemen are gentiles. Glucose makes a rather poor adhesive, but one who is hard put for mucilage might so use it with indifferent success just as it is possible to use tapioca pudding, molasses or other sticky foods.

Turning to the advertising literature of the glucose manufacturers, we note that many eminent authorities laud glucose as most wholesome, that it is the principal sweet of fruits and one of the intermediate products of the digestion of starch in the human organism, is found in the blood,—and similar statements, all of which like the damning ones of some pure food experts are "important if true."

Notwithstanding that annually between thirty and forty million bushels of Indian corn are made into glucose, comparatively few except those engaged in the numerous industries in which glucose enters, ever see the product. The idea of the general public, professional as well as the laity, seems to be that glucose is mostly composed of grape-sugar which is made according to the Kirchoff method by boiling starch and oil of vitriol and neutralizing the mixture with chalk. Many supposedly up-to-date cyclopaedias make such statements.

Much of the ignorance concerning this important food product is due to the following facts: Pure commercial glucose is practically unknown in household cookery, and so is not sold in a package convenient for household use. While it is in multifarious food products found on the grocer's shelves it is rarely seen there in its original state. This is equally true of raw sugar. Years ago, raw open-kettle sugars were familiar to all New England housewives and were used by them in cooking. Raw sugars made by modern processes are used to some extent now in England and European countries, but nowadays few of the citizens of this country, outside of the sugar producing districts, ever see raw sugars, which are sent directly to the refineries in packages weighing several hundred pounds each and in a condition not fit for domestic use. Glucose, like refined sugar, is manufactured in comparatively few factories, and these of large capacity, for the manufacture of glucose requires a large outlay of capital and consequently large output. The cheapness of the prod-

uct makes its manufacture profitable only on a large scale. This is equally true of sugar.

What is commercial glucose? In general appearance it is a transparent, very viscous sirup, often practically colorless but usually of a light straw color, sweet, but with little if any other flavor. For this reason, glucose, like sugar, has been termed a "neutral sweet,"—not neutral in the chemical sense—although such products are always chemically neutral within practical limits of testing—but so called because when pure they have no characteristic flavor other than sweet and will take any added flavor unchanged.

Glucose is not made by use of oil of vitriol and chalk, nor is glucose, in the ordinarily accepted sense of dextrose, its characteristic ingredient. The trade name "glucose" while well established by custom of years is no more suited to the present product than is "chloride of lime" to bleaching powder or "hyposulphite of soda" to the commercial salt sold under that name. It is true that the basic process by which glucose is made from starch is on the lines of Kirchoff's original experiment, but the methods are quite different. The "starch milk," a suspension of the granules in water, is pumped into large pressure boilers of gun metal, and is cooked for about ten minutes with a few tenths of a per cent. of hydrochloric acid (commercial muriatic acid) under a pressure of about 50 lbs. of steam. The starch is not treated long enough by this process to convert it entirely into grape sugar (true glucose), only about 20 per cent. being produced. There is, in fact, less of the glucose sugars, properly so called, in commerical glucose than occur as natural ingredients of cane sugar molasses, and far less than in honey, which is composed almost entirely of glucose sugars, nearly half of which is dextrose (grape sugar), this being the sugar which separates out when the honey granulates.

Commercial glucose as now made contains less than 20 per cent. of true glucose sugars, the rest being a mixture of malt sugar (maltose) and dextrins, more or less in chemical combination in the approximate proportion of nine parts of maltose to seven of dextrin. In percentages of total sugars and dextrins, there are in round numbers,—maltose, 45 per cent., dextrose, 20 per cent., dextrin, 35 per cent., the proportions varying somewhat in different lots.

These three carbohydrates, *dextrose,* which is a true glucose sugar, *maltose,* belonging to the cane sugar family, and making up nearly half of the total, and *dextrin,* a gummy ("colloidal") substance closely related to starch paste, compose over 99 per cent. of the solid matter of refined commercial glucose. This composition has been found to be the most desirable for imparting to the product the properties most suited for a sirup which can be refined readily, and at the same time contain enough colloidal material to prevent its crystallizing at any concentration. This colloidal matter also renders the sirup capable of dissolving considerable amounts of cane sugar without crystallization. Such a product is peculiarly valuable in the preparation of sirups, candies, preserves, and jellies, quite apart from its use as a sweet. It also contains nearly the maximum amount of malt sugar that can be produced by such a process.

The rest of the dissolved substance of commercial glucose consists of 0.3 to 0.5 per cent. of mineral matter, mostly composed of sodium chloride from the neutralization with soda of the hydrochloric acid used in the manufacture, sulphites which are added at various stages, phosphates and other salts from the natural mineral matters present in minute quantities in the starch or coming in part from the boneblack used in the refining process. There is also about 0.08 per cent. of nitrogen corresponding to five or six times its weight of organic substances from the gluten left in the starch. Much of this nitrogenous matter is not gluten, but simpler organic compounds resulting from the action of the acid (used to convert the starch) on the gluten. These nitrogenous matters have much to do with the quality of the

glucose, and it is on this account that they are of peculiar importance although present in minute amounts. The impurities from the gluten which are less acted upon by the acid, the "albumoses," give trouble to the candy manufacturer by causing foaming in his kettles, while this property is the joy of the brewer. Those gluten substances which are changed further by the acid, the "amino bodies," tend to make the glucose darken and also impart a flavor which though barely perceptible is disagreeable—bitter or fishy. Manufacturers used to correct the objectionable effects of these impurities by the addition of sulphites to the glucose but this was but a temporary expedient and undesirable in a food product. Glucose has been much improved in recent years by practically eliminating the effect of these impurities by more efficient purification of the starch used in its manufacture.

The glucose process does not end with the acid treatment of the starch and the neutralizing, as at this stage the dilute sirup is far from pure, containing oily matters from the corn, some undecomposed gluten and other impurities mostly in suspension. This liquor before it is concentrated to a sirup of about 80 per cent. solids undergoes a refining with boneblack closely resembling that of cane sugar, the apparatus being practically identical—filtering through bags and boneblack filters—but in the case of glucose all impurities affecting the quality of the sirup have to be removed or destroyed as there is no purification by crystallization.

Hence, glucose, like granulated sugar, is one of the purest food products in use, however pernicious the properties that may be ascribed to it.

Space does not allow a detailed description of glucose manufacture which is of great interest owing to the numerous by-products which are made, and also because while glucose is the chief in output, its manufacture is only one of many starch products carried on at the same time.

The following table, taken from an advertising circular of a manufacturer, shows in a concise way how the different parts of the corn kernel are utilized:

Parts of Corn Kernel	*Composition*	*Products*
1—Germ	Oil and Oil Cake	Corn Oil, Corn Oil Cake, Corn Oil Meal.
2—Endosperm (Body of the Corn)	Starch	Dry Starches, Dextrines, and, by conversion, Corn Sirups [glucose] and Sugars.
	Gluten	Gluten Feed.
3—Hull	Bran	Gluten Feed.
4—Water added for steeping	Soluble Substances of Corn	Gluten Feed.

The oil is used principally for soap and for making vulcanized products used for rubber substitute. The oil-cake and meal from the cake are used as cattle feed. The gluten and bran from the starch, mixed with the soluble matters extracted by the water used to soften ("steep") the grain before grinding is made into "gluten feed" also for cattle. All these are valuable by-products for which there is a good market. The starch in a moist state, known as "mill starch" is the raw material for making the various goods which are sold under the names of "glucose" ("corn sirup"): "corn sugar" ("grape sugar"), the latter a hard product which is largely composed of dextrose, but never known in trade as "commercial glucose" and little used as a food product; "dextrins," true adhesives which are usually made by roasting starch and entirely different in characteristics from the dextrin ingredient of commercial glucose; besides numerous "dry starches" used by laundries, confectioners, and in many other industries as well as for household purposes.

At present prices, commercial glucose, a sirup containing about 80 per cent. of the pure carbohydrates in solution sells at about $2\frac{1}{4}$ cents per pound (26–28 cents per gallon) or at about 2.7 cents per pound of actual dissolved substance. Is its sole use that of an adulterant of better food materials as some food reformers claim? Is glucose used to adulterate our ordinary grocery sugars?

It is well known in the history of the industry that some thirty years ago a Chicago concern spent some millions of dollars and much valuable time in

trying to adulterate fine grained white sugars with solid grape sugar of high quality, made from starch, but the attempt failed miserably simply because the stuff would not stay mixed and the grains "set" in a solid mass after a short time. In years gone by, glucose was also much used to mix with cheap, poor grade molasses making a brighter, more attractive product which, so improved, could be sold at the price of higher grade molasses. This form of adulteration is so easily detected that it is rarely resorted to in these days of pure food legislation. The last case which came to the writer's notice was one of a New York molasses dealer who was heavily fined for having a few per cent. of commercial glucose in his molasses although his defence was a plausible one—that the glucose was some accidently left in the barrel, old glucose barrels being much used for tropical molasses shipments.

Glucose is now used in a legitimate manner to mix with cane-sugar sirup in the proportion of 85 per cent. of glucose to 15 per cent. of sirup, a little salt and sometimes vanillin being added to improve the flavor. The cane-sugar sirup is usually refinery molasses ("barrel sirup") which imparts the principal flavor. These mixed sirups are sold openly as glucose or "corn sirups" and as their flavor is superior to the original molasses there seems to be no reason why they are not wholesome food products for legitimate trade, even though some people there are who prefer, the flavor of the sirups made from the natural cane juices and are willing to pay the higher price for such. Certainly, such glucose sirups are preferable to the average grocery molasses either from the standpoint of the epicure or the sanitarian.

Commercial glucose is used in large quantities in the manufacture of cheap jams and preserves. Apple cores and skins from fruit in its preparation for evaporation or preserving are the basis for most cheap jellies; the pecten substance and juice being extracted by the usual processes of jelly making and mixed with glucose and sugar forms a jelly material to which other fruit juices are added. The law requires such jellies to be plainly described on the label so that the consumer is informed that he is using a jelly made of apple and glucose with a fruit flavoring, and is at perfect liberty to buy the pure glucose-free fruit product if he so prefers. What interests the public is: Are these cheap jellies unwholesome, or is there other reason why the man with the slim pocketbook should not buy them? This question is quite apart from whether they contain glucose or not, but deals with the soundness and wholesomeness of the ingredients used and the cleanliness of their preparation.

By far the largest amount of glucose is consumed in the manufacture of candy, the peculiar properties of this sirup making it especially valuable in this industry, as has been explained. The requisite for most candy is that it should not "grain" (crystallize), and glucose, owing to its colloidal nature, is the most effective and wholesome substance to prevent this. The popular impression that glucose is used in candy-making because it is a cheap substitute for sugar and that its sole function is to give sweetness is only approximately correct.

How sweet is glucose relative to cane sugar? Determinations of the sweetness of a saccharine product are very unsatisfactory owing to personal equation and also to the influence of the other mixed ingredients and even the physical condition of the substance tested.

Granulated sugar tastes sweet. Powder it in a mortar and it will taste less sweet. Owing to this fact it is hard to convince some people that powdered sugar is not adulterated, although this practice, easily detected, is practically unknown at present. A quarter of a grain of quinine mixed into a pound of granulated sugar is said to make it taste sweeter. Common salt in small quantities will improve the sweetness of cake and other sweet foods, as all cooks know. Raw sugars, even when they contain negligible quantities of the sweeter mother-sirups, taste distinctly sweeter than granulated sugar although their actual sugar content is less. This is due to the salts

and extractive matters in the raw product, and it is why many cooks sigh for the old-fashioned open kettle sugar and even prefer the refiners' imitation goods to granulated in making their apple pies.

Relative tests of the sweetness of cane sugar and glucose (*dextrose*) have been made by dilution experiments on the pure sugars, but as far as the writer knows, no relative tests of the sweetness of commercial glucose as now made have been published. Taking this value to be .5 for the solids in glucose, sugar at 5 cents is cheaper as a sweetener than glucose.

As a matter of fact, very little candy is made with glucose as the only sweet. Usually, candy contains 60 per cent. or more of cane sugar, the sweetening of the glucose being of much less importance than the other properties it imparts to the mixture.

It seems reasonable to infer that commercial glucose rather than being a serious competitor of cane sugar has really increased the consumption of the latter, especially in candies. Because of the great advantages from the use of glucose in candy-making, the industry has had an impetus which has greatly increased sugar consumption.

The relative wholesomeness of candies made from glucose and those made from cane sugar has never been decided, and may never be. The dextrins of "glucose" as now manufactured are in great part in combination with the malt sugar and seem in every way identical with the malto-dextrins obtained by the action of malt on starch, and are digested more in the intestines than in the stomach as compared with pure sugar candies. Whether this is an advantage or not, the physiologists must decide.

Glucose is extensively used in industries not making food products. It is used in cheap soaps, for "filling" leather and tanning extracts, and as many of its uses in such industries are apparently for adulteration such practices have no doubt added to its reputation as the "champion adulterant." As was pointed out in an article in a previous number of this magazine,* on the industrial uses of sugar, the highly respectable beet sugar of 99 per cent. purity is used in Europe for precisely the same purposes, the choice between sugar and glucose as a "filler" being merely a matter of price. Cane sugar has also been used extensively to "fill" coal-tar dyes and adulterate chocolate without having its respectability seriously impugned.

In view of the undoubted commercial importance of glucose as a food product it would seem as if its value in dietetics and food economics, as well as its relative wholesomeness, ought to be studied in the light of a proper knowledge of its special characteristics. To call glucose "mucilage," or to ascribe to it properties of a dextrose solution is either ignorant or dishonest. As far as the use of glucose as an adulterant is concerned, it is the function of the Pure Food Laws to protect the public from these practices, and such obviously are quite apart from the legitimate and open use of glucose, sugar or any other cheap and wholesome food product as a satisfactory substitute for more expensive ingredients, and the propriety of such a substitute always will be its suitability for the purpose and its cost.

If legislation is appropriate for forbidding the extravagant claims of manufacturers and dealers as to the superiority of their food products, why not legislation to prevent irresponsible statements of "pure food" authorities which are condemnatory? Certainly, the one is as important for the public interest as the other.

INFECTION FROM TOWELS

Recently an investigation has been carried out by Zinsser and Hopkins on the viability of the *Spirochœta pallida*, the organism causing syphilis, when exposed on a towel to diffuse light at room temperature. By moistening pieces of towel with a culture of the organism and then exposing it for various periods they found that infectivity could still be demonstrated at the end of eleven and one-half hours. Since the lesions of secondary syphilis are often found on the face, the danger of the common towel and the possibility of innocent infection are clearly shown. E. A. I.

*Science Conspectus No. 2, 1913.

SALT AND ITS RELATION TO NUTRITION

CARNIVORA EAT LITTLE SALT — THE DESIRE OF VEGETARIAN ANIMALS FOR SALT PROBABLY DUE TO EXCESS OF POTASSIUM OVER SODIUM IN THEIR FOOD

BY PERCY G. STILES

Common salt is a commodity, the annual production of which is known to exceed 12,000,000 tons. Of this huge total a large share is used as a preservative or otherwise employed in industry, yet an immense quantity is deliberately added to the diet of mankind. It is said that an individual consumption of 20 grams a day is not unusual. This average, sustained for a year, would amount to about 17 pounds. The ration appears surprisingly large when we observe that it may be as much as one quarter of the total weight of protein taken and equal to one twelfth of the combined starch and sugar which constitute our main dependence for running the human engine.

It is agreed by all writers on the subject of nutrition that only a small part of this salt consumption is necessary. The rest is dictated by appetite; it is due to the common liking for the salty flavor. Individuals are found who do not care for this and who are said to eat no salt. This means that they use none voluntarily at table and perhaps direct that none shall be used in the kitchen. Yet they continue to receive a small salt ration because some is present in most foods and there is reason to believe that this minimal supply cannot be dispensed with. Sodium chloride is the chief salt in the blood and in the other fluids of the body. It is accordingly plain that growth cannot be continued unless this compound is furnished along with the other necessary nutrients.

When full stature is reached the need for salt is doubtless diminished. It might cease entirely if it were possible to avoid all loss of salt in the excretions. This possibility is nearly but not quite realized. When a man fasts for several days the escape of sodium chloride from his system sinks to a low level but remains appreciable. It may be in the vicinity of 0.6 gram in the twenty-four hours. In complete starvation this gradual loss is probably not out of proportion to the general reduction of weight. Hence it does not lead to an actual lowering of the percentage of salt in the body. A diet sufficient in all other respects, but lacking salt, might bring to pass such a lowering.

One interesting result of using a salt-free diet has been observed in the failure of the glands of the stomach to produce hydrochloric acid. This valuable aid to digestion and antagonist of putrefaction must be evolved from the chlorides of the blood. Apparently it is not secreted when the concentration of these substances in the blood is at all below the normal and this in spite of the fact that the chlorine ions of the gastric juice can probably be recovered quite successfully. The suggestion has been made that rigid restriction of salt should be beneficial in cases where the gastric acidity is excessive.

Bunge, an Austrian physiologist, has collected a great volume of data concerning the habits of different races as to the use of salt. It is evident that some people set a high value upon it while others do not care for it at all. Where it is prized it has often figured in maxims and metaphors. "To earn one's salt" is a familiar phrase which gains point from the common origin of the words "salt" and "salary." Bunge learned that a certain East Indian tribe used as the most solemn oath in their court procedure the formula, "May I never taste salt again if I speak not the truth."

A little investigation shows that the desire to add salt to the food is experienced most by those who are vegetarians

or nearly so. Men who are strictly carnivorous abhor salt. Thus it was found by the agents of the Russian government that the natives of Kamchatka could not be prevailed upon to salt the fish which formed their entire diet. The supply of fish was uncertain and that which was saved to eat in the long intervals between catches decomposed in shallow pits. Still it was preferred to salt fish. We notice the same detestation of salt among carnivorous animals. They present a marked contrast to many of the herbivora, like cattle, sheep, and deer, which are very fond of salt.

The Arctic explorer Stefansson has recently reported a striking instance of the objection to salt which accompanies the use of a flesh diet. The Esquimaux, whom he knows so well, have little vegetable food. When he settled among them he was embarrassed by their demands upon his hospitality. Policy dictated that he offer them food on all occasions but there was every prospect that his stores would be rapidly depleted. The situation was relieved by a simple device. It was only necessary to salt the food moderately—merely to his own liking—to deter his visitors from making inroads upon it. The requirements of courtesy were satisfied and the provisions were conserved.

When a sample of food is burned as completely as possible the mineral constituents remain as ash. Chemical analysis of this ash leads to very different findings in the case of different foods. Several acids and bases will always be found. We will consider only the occurrence of sodium and potassium. The ratio between the quantities of these two bases is widely varied, though in the great majority of instances potassium is the more abundant. In animal foods the disparity is not marked but in most vegetable substances it is striking. For example, the proportion of potassium to sodium in meat (veal) is 4 to 1, while in potato it is more than 30 to 1.

Can we recognize a causal connection between the excess of potassium in a vegetable diet and the craving for sodium chloride which is attendant on the use of such a diet? Bunge maintains that we can. His explanation has been criticised in detail but is probably valid in its main thesis. The absorption into the blood of a quantity of salts, unlike those normally present there, imposes upon the kidneys the duty of restoring standard conditions. If the chief demand is for the removal of potassium compounds the task will soon be accomplished. But this will not be done without a considerable loss of sodium chloride. It would be remarkable, indeed, if the kidney cells could select all the foreign ions and not occasionally let slip some of the much more numerous native ones.

Bunge was able to demonstrate, upon himself, the fact that an excessive intake of potassium salts does lead to a loss of sodium chloride. He swallowed as much potassium phosphate and citrate as he could tolerate and subsequently excreted all the potassium—equivalent to 18 grams K_2O—but simultaneously eliminated 6 grams of sodium chloride. Such a draft upon the tissues could not be continued indefinitely unless salt were supplied in corresponding amount. Bunge's personal experiment was not an unreasonable one, for it is calculated that when potatoes form the bulk of a man's ration twice as much potassium may be ingested as in this trial.

There is, therefore, no doubt that salt is a necessary addition to diets in which the ratio of potassium to sodium is unusually high. The instinctive craving for it is a marvelous instance of the almost infallible correctness of such impulses. Bunge has recorded the use by an African tribe of the ash of a certain tree as a seasoning for their food. Most kinds of wood reduced to ashes would yield a mixture over rich in potassium which would be a most undesirable adjunct to other articles of vegetable origin. But the tree in favor with these people was the rare exception; its ash contained a most unusual proportion of sodium compounds. It is rather painful to fancy the tedious succession of experiments by which the ancestors of this tribe eliminated various kinds of wood, and pleasant to imagine the satisfaction realized when the fortunate choice was finally made.

SCIENTIFIC AERONAUTIC RESEARCH

DESCRIPTION OF THE NEW AERODYNAMIC LABORATORY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY WHICH PUTS AEROPLANE DESIGN ON AN ENGINEERING BASIS

BY J. C. HUNSAKER

Air craft have become in the last few years primarily war material, and as such, are designed to meet definite specifications of performance. Five years ago the supreme test of an aëroplane was whether it could fly or whether it could not fly. Now we inquire how fast and how slowly it can fly, what is its rate of climb, useful load, and radius of action? For example, for military uses, armies require a slow endurance machine for strategic scouting which can make raids into the interior of an enemy country. For tactical scouting over the field of battle, where enemy aëroplanes must be evaded, an army requires a scout of great speed but limited radius of action. Such a machine must have speed and climbing ability superior to that of the enemy units. A third type called a "fighting aëroplane" is necesary to drive off enemy scout aëroplanes. Such a machine must combine the greatest practicable speed and climbing rate with the extra weight of an armored body and a machine gun with a gunner. The performance required for such a destroyer is fixed by the probable ability of enemy scouts to elude it. A fourth type of military aëroplane may soon be developed for the purpose of bomb-dropping. Here the designer would be required to produce a machine able to transport great weight over a long distance.

In all the cases mentioned above the entire military value of the aëroplane lies in its performance, and the burden is thrown on the designer to produce a machine to meet all requirements. Just as in naval architecture, the problem is a compromise between the conflicting claims of speed, armor, armament and radius of action.

In view of the necessity for designing aëroplanes to possess given qualities, a designer must guarantee performance. A desired type can, of course, always be reached by building a series of machines but this procedure is extremely costly in time and money, and requires a pilot to risk himself in experimental flights on under-powered and unstable machines.

The problem of aëroplane design involves so many variables that it is often impossible to arrange experimental flights so that changes are made in but one variable at a time. The peculiar conduct of an experimental machine may often be blamed on any one of some half dozen features of its design, and as a result the tests lead only to endless discussion.

On the other hand, it is well established that the performance of an aëroplane can be predicted from experiments on a small model, geometrically and dynamically similar. Model tests are easy to conduct and afford the great advantage that radical alterations of the model may be made without loss of time or risk of life. Furthermore, in model testing, the various parts of an aëroplane may be tested separately to determine the effect of each part on the performance of the complete machine.

In naval architecture, a designer has a small model of his ship towed in an experimental model basin. From the resistance of the model, he can estimate the resistance of his ship and so guarantee its speed for given power.

For purposes of aëroplane or air ship design, it is possible to tow models in air in a similar manner. However, in aëronautics the problem is extremely complex since in flight, motion is possible

Suction end of wind tunnel

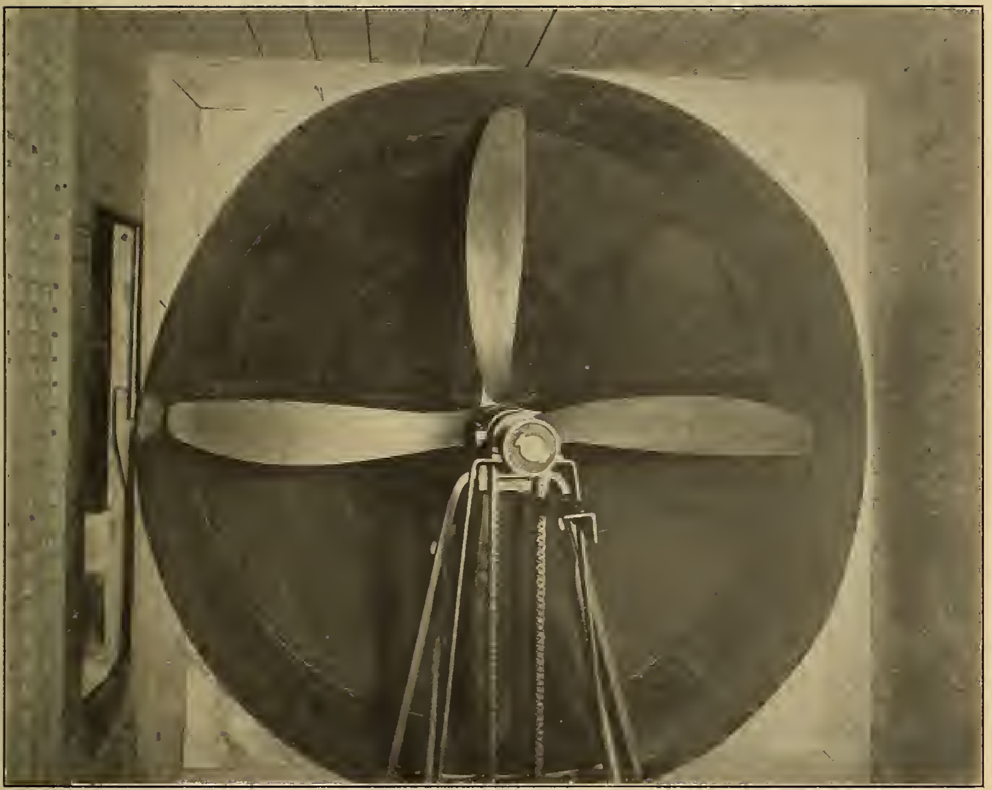
along the three axes in space, as well as rotations about any of them. In general, the effect of the air on a solid object moving through it requires the measurement of three forces and three couples corresponding to the three axes of space.

Towing experiments become mechanically difficult to arrange, and in view of the high speeds required in aëronautics a long building like a rope walk is necessary. Such tests have been made at the Kiel Navy Yard in Germany and at the University of Paris. At the latter institution a dynamometer car running along a track carries objects under test mounted on a weighing mechanism. The tests are conducted in the open air and are subject to error due to gusty winds.

If it be accepted that aërodynamic forces depend on the relative motion of air and object under test, it is immaterial whether the object be towed in still air at a given velocity, or held stationary in a uniform current of air of the same velocity. The use of an artificial wind is the "wind tunnel" method, which has come into general use abroad. The doctrine of relative motion is fundamental in mechanics, and discrepancies between results of tests made by the two methods may be ascribed to the probability of errors due to the influence of the car and wind gusts in the towing method, and to irregularity in the flow of air in the wind tunnel method.

The validity of wind tunnel tests depends upon the uniformity of flow of the air. The production of a current of air that shall be constant in velocity, both in time and space, is a difficult problem.

When it was decided to build a wind tunnel at the Massachusetts Institute



Propeller for wind tunnel

of Technology for use by students in aëronautical engineering, a study was made of the most successful wind tunnels abroad. The conclusion was reached that the staff of the National Physical Laboratory, Teddington, England, had developed a wind tunnel of convenient form and of a high degree of uniformity of flow. This tunnel was the result of a methodical series of experiments with wind tunnels of various forms, in which the following conclusions were reached:

1. Models should be placed in the suction stream leading to a fan where turbulence is least.

2. A four-bladed aëroplane propeller of low pitch gives a more steady flow than the ordinary propeller fan used in ventilation work, and a much steadier flow than any blower of centrifugal type.

3. The wind tunnel should be completely housed to avoid the effect of outside wind gusts.

4. Air from the propeller should be discharged into a perforated box of great volume, to damp out turbulence, and to return the air at low velocity to the room.

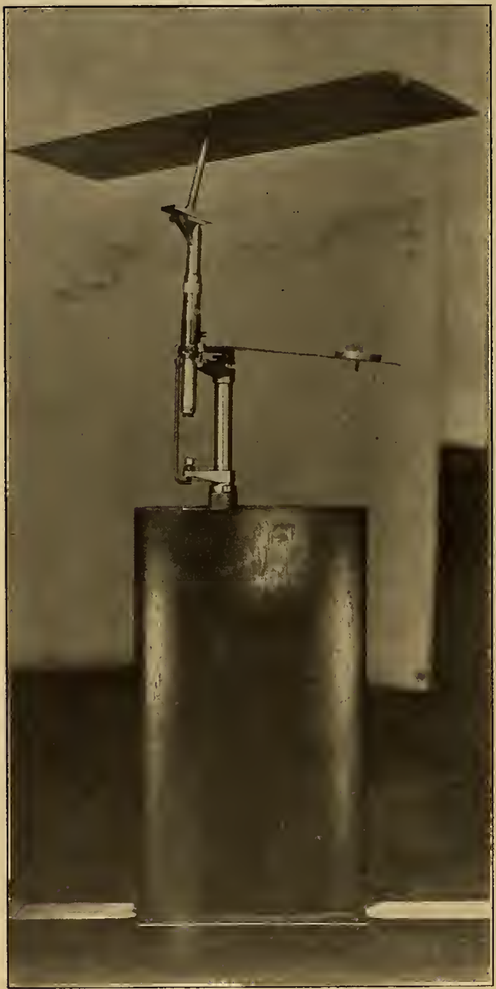
5. The room through which air returns from the perforated box to the suction nozzle should be at least twenty times the sectional area of the tunnel.

The wind tunnel of the Massachusetts Institute of Technology was built in accordance with the English plans with the exception of several changes of an engineering nature introduced with a view to a more economical use of power. An increase of the maximum wind speed from 34 to 40 miles per hour was thus obtained.

Upon completion of the tunnel an investigation was made of the steadiness

of flow. It appeared that the variation of velocity with time and from point to point of the cross section was not more than one per cent.

The wind tunnel proper is a square trunk 16 square feet in section and 53 feet in length. Air is drawn through an entrance nozzle and through the tunnel by a propeller driven by a 10 H. P. motor. Models under test are mounted in the middle of the tunnel on the arm of a delicate balance.



Wing model in position for test

The air entering the mouth passes through a honeycomb made up of a nest of three-inch metal conduit pipes. This honeycomb has an important effect in straightening out the flow and in preventing swirl.

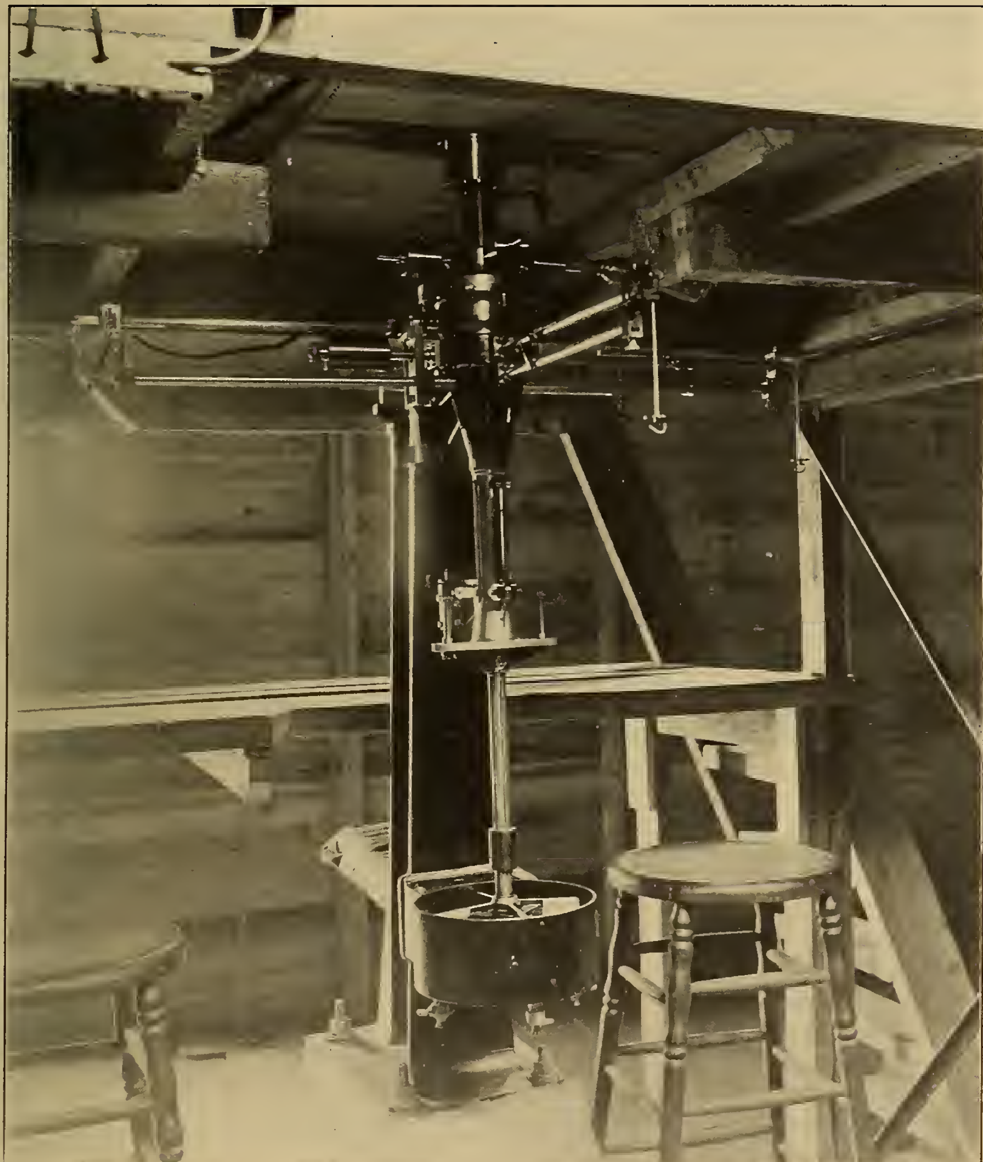
Passing through the square trunk and past the model under test, the air is drawn past a star-shaped longitudinal baffle into an expanding cone. This cone expands in 11 feet to a diameter of 7 feet. The velocity of the air is reduced in passing through the cone and has its pressure increased in accordance with a well-known hydraulic principle.

The propeller is made of black walnut with four blades. It works at the large end of the cone and discharges into the diffusor. The latter is built of wood grating with holes closely spaced except on the side facing the propeller which has no openings. The propeller race is stopped by this wall, the velocity of the air destroyed and the pressure raised. The air then escapes through the holes in the diffusor into the room. The current is thus turned through 90 degrees and brought nearly to rest.

The propeller was designed on the Drzwiecki system, which assumes that each blade section is an aëroplane wing moving through the air in a spiral path. In order to keep down turbulence, a very low pitch and a broad blade were used. To gain efficiency the blades were made thin and, therefore, weak. To prevent fluttering of the blades, the blade sections were so arranged that the centers of pressure of all sections lie on a radial line drawn on the face of the blade. This artifice seems to have prevented the howling at high speeds commonly found with thin blades.

The propeller is driven by a "silent" chain from a 10 H. P. inter pole direct current motor. The propeller and motor are mounted on a bracket structure fixed to a concrete block and are hence independent of the alignment of the tunnel. Vibration of the motor or propeller cannot be transmitted to the tunnel as there is no connection.

In order to maintain a steady current of air, the fan must run at constant revolutions per minute, but in order to allow a fine adjustment to obtain and hold any



Aërodynamic Balance

speed, a direct current motor is necessary. To run a direct current motor at constant speed requires a steady voltage. Such is not available. Consequently the following procedure was adopted. A 15 H. P. induction motor is connected to the alternating current power mains of the Cambridge Electric Company. This induction motor is coupled directly to a 12 H. P. direct current generator. The generator supplies current to the motor which turns the propeller. For constant wind speed, the load is constant and hence the induction motor will turn over

Chattock micro-manometer (above), Krell manometer (below)

at constant speed since its slip is a function of load. Variation of voltage in the city mains has small effect on the speed of the induction motor, which runs at a speed proportional to the frequency of the supply current. The generator being turned at constant speed generates constant voltage, and the propeller then runs at constant speed. Due to slow changes in frequency it is necessary to provide variable resistance in the direct current motor field, by the use of which the wind speed can be corrected from time to time.

Any wind can be made of velocity between 3 and 40 miles per hour.

The model of complete aëroplane, wing, tail, body or other part is mounted on an aërodynamic balance constructed from the plans of the National Physical Laboratory, England. This balance consists of a cast pillar mounted on an independent concrete block, and the balance proper. The latter is made up of three arms mutually at right angles representing the axes of coördinates in space about and along which couples and forces are to be measured. The model is mounted on the upper end of the vertical arm which projects through an oil seal in the bottom of the tunnel.

The entire upper part of the balance ıests on a steel point, bearing in a steel cone supported by the cast iron pillar.

The balance is normally free to rock about its pivot in any direction. When wind blows on a model, the components of the force exerted are measured by hanging weights on the two horizontal arms to hold the model in position.

The balance is also free to rotate about a vertical axis through its pivot. The moment producing this rotation is balanced by a calibrated torsion wire.

Special attachments permit the measurement of the force in the vertical axis and moments about the two horizontal axes.

The three forces and three couples acting on any model placed in any attitude

to the wind can be studied at leisure. The balance is precise to one per cent.

Velocity is measured by means of a Pitot tube which was calibrated on the whirling arm at Teddington. The Pitot tube pressures are read on a Chattock liquid micro-manometer. Velocity readings are precise to one half of one per cent.

Tests have been made to determine the lift and resistance of a model aëroplane wing which had previously been tested in England. The results are in excellent agreement and indicate that the English tunnel and balance have lost none of their precision in the rather extensive alterations that have been made here.

The wind tunnel has been in operation since July, 1914, and has been used for comparison of Pitot tubes, determination of the aërodynamic coefficients for a number of wings, bodies, and miscellaneous objects, for thesis work on aëroplane stability and by students in connection with problems arising in the course of aëroplane design.

It is hoped that in following up design by wind tunnel testing, aëroplane design is being placed on a rational engineering basis.

MOSQUITOES NOT ALWAYS RESPONSIBLE

A paper by Dr. Charles S. Braddock of New York, late chief medical inspector of the Royal Siamese Government, published in the *New York Medical Journal* has attracted a great deal of attention lately by presenting evidence that mosquitoes are not the only means by which malaria is transmitted. Dr. Braddock points out that, while care was taken to show that water, clothing, and association were incapable of transmitting yellow fever, the studies on malaria merely demonstrated that mosquitoes transmit the disease and failed to show that it was not also transmitted by water or by direct infection from the soil. The Italian scientists in their classical studies lived in a house with a floor raised above the ground and drank either wine or boiled water. Dr. Braddock brings forward numerous instances from his experience in Siam, French Indo-China and the Malay States and from his observations when a lieutenant of the line in the United States, in the United States Navy and when serving in Cuba and Hayti which tend to show that in a country known to be malarial and among men who were equally protected from mosquitoes those who drank raw water or slept on the ground contracted the disease, while those who drank boiled water and slept on cots raised above the ground remained well. He also cites the case of a section of Siam which is notorious as a hotbed of malaria but in which there are no mosquitoes.

The general experience and opinion has too much weight to be readily upset, but the idea may set on foot some interesting studies on the subject. E. A. I.

PLUMB LINE VAGARIES

The fact that de Filippi in his exploration work in Kashmir is paying a great deal of attention to gravimetrical observations calls attention to the unusual deflection of the plumb line in northern Hindustan. This has been theme for discussion in a number of the Professional Papers of the Indian Survey, and a sketch of the status of the subject is presented in a recent geographical journal. A high northerly deflection has been observed to reach its maximum along the southern edge of the Himalaya range, decreasing on both sides. Colonel Burrard, in 1912, suggested a deep rift in lower layers of the earth's crust, filled in the course of ages by material of less specific gravity than the rock formations on either side, and he further suggested an origin for the rift coeval with the uplifting of the mountains. The idea has not been a popular one with geologists who claim that such a rift, a wedge twenty miles deep and only five in width at the surface, is anomalous. The Indian geologists suggest instead that south of the great fault that marks the Himalayan margin there is an immense depression which has been filled with the alluvium that now constitutes the plain of the Ganges and this is of much lower specific gravity than the mountain rocks.

BATESON'S THEORY OF EVOLUTION

THE ORIGINAL MICROSCOPIC EGG CONTAINED THE ESSENCE OF EVERY DEVELOPMENT IN LIVING THINGS — SUDDEN EVOLUTIONARY VARIATIONS SUBJECT OF DISCUSSION

BY HERVEY W. SHIMER

There has been much discussion of the address on Heredity delivered by Dr. William Bateson this past summer in Australia in his office of president of the British Association for the Advancement of Science. At first reading it seems subversive of nearly all of the structure of evolutionary theory that has been slowly building since Darwin's time. In reality, however, it may be regarded merely as a fuller application than has hitherto been attempted of the Mendelian or analytical method of study to the facts of organic life and heredity. The result is that while we still look to Darwin as unquestionably the first to provide a body of facts showing the variability of all living things, we must disagree with him in regarding natural selection as the chief factor in this variation, that is in the origin of species.

Darwin was the first to demonstrate by an immense body of illustrative data the fact that all living things vary, that every animal and plant differs, often in a barely perceptible degree, from every other animal and plant. This he explained as the result of the action of the environment which must of course be different in at least some small measure for every being. Certain characteristics of the organism fit in with the environment favorably, certain others are antagonistic. Those favorable thrive and tend to be reproduced in the succeeding generation, and are thus perpetuated; those unfavorable are thwarted and suppressed or if prominently antagonistic to the environment cause the death of the organism and hence die out with its generation. This is the theory of natural selection and to its agency Darwin attributed the fact of variation, and of the origin of species among animals and plants. This, Darwin considered to be the most important method of evolutionary change though he recognized likewise the occurrence of sudden changes later emphasized and elaborated by DeVries in his treatment of the mutation theory. This doctrine of cumulative variation naturally results in a conception of evolution as a slow and a steadily progressive movement; through this, one form is gradually changed into another by the addition of minute characters which have originated in spontaneous variation and have been selected by the environment and thus perpetuated and passed on by heredity to the succeeding generations.

For this conception of evolution Bateson asks us to substitute one that he likens to the unpacking of an original complex. The earliest primordial speck of life contained the whole range of diversity which living things now present or may in the future develop. And variation simply means that certain lines of organic descent emphasized certain of these possible characteristics, leaving the others, and passed them on to their descendants which again selected from those handed on to them. Thus evolution instead of being a process of addition of factors is a process of continual subtraction.

This selection of variations proceeds according to the law of heredity discovered by Mendel whereby certain characters of the organism are dominant, *i. e.*, in control and appear in the lifetime of the individual, and others are latent and do not appear although they may be passed on to their descendants.

And Bateson asks whether, if it seem absurd that the earliest form of protoplasm could have contained complexity

enough to produce the divers forms of life, it is any easier to imagine that these powers could have been conveyed by additions from without.

To the possible variations given to an animal or plant by this process of subtraction from the original complex is added the wide range of possibilities due to crossing, whereby the organism gets the possibilities of the two complexes which are its parents.

It would seem as though this conception of evolution as a passage from the complex to the more and more simple, in which the organism specializes in certain characters and drops off certain other possible characters might be likened to the manner of our social evolution. In pioneer days every man is a complex of industrial possibilities—he is his own carpenter, blacksmith, cobbler and physician. In the course of time his descendants specialize more and more, each adopting some one line of industry and leaving behind the other possible activities. Emphasis on some one specialty seems to be the necessity in evolution.

It would, in short, seem that Bateson asks us to consider two main theses:

First, while it can never be questioned that Darwin was the first to provide a body of facts demonstrating the variability of living things, yet we must come to the conviction that his principle of natural selection cannot have been the chief factor in the delimiting of the species of animals and plants. It is asked that we consider that this variation has rather resulted from the fact that to each species has fallen a different set of characters in the unpacking of the original, all-containing ancestral protoplasm—that to each succeeding generation falls a slightly differing set of characters according to the Mendelian law of inheritance.

And in the second place and as a natural consequence of this different evolutionary procedure, we must think of evolution not as slow and cumulative by the gradual accretion of minute variations but as mutational. That is, while according to the Mendelian law, an individual may so closely resemble its parents as to be barely distinguishable, yet the operation of this same law permits of possible sudden deviations whereby a character, heretofore passed down the line as latent, may suddenly appear when some other character which has inhibited it, is removed.

The evolution of Bateson is an evolution of continual subtraction and of sudden variations. Evolution occurs by sudden changes alone, never by gradual variation.

We cannot doubt that evolution occurs—that every organism now on this earth differs from every other organism either of the present or of the past. But it is the question of how they come to be different that is still the subject of theory and controversy.

CASEIN FOR THE TOILET

While the original cold cream may have been made of true cream, the formula in the United States Pharmacopeia of the present day shows that it is a mixture of spermaceti or stearic acid with bees' wax and oil of almonds with a little borax added to aid in keeping the mixture homogeneous. Many of the modern massage creams, especially those advertised as greaseless, have as their most important constituent casein, the substance precipitated from buttermilk. Truly it is a remarkable substance which may be used with equal success for cheese, buttons, billiard balls or face cream.

E. A. I.

BLASTING WITH LIQUID OXYGEN

By a recently discovered method, it is thought that a practical way has been found for using liquid oxygen in blasting. Bags filled with a special form of lamp black are soaked in liquid oxygen a few minutes just before being needed. They can be detonated with the force of dynamite. There is no danger from a misfire, as the oxygen will evaporate in a short time if not exploded soon after being soaked in liquid oxygen.

SOME INSECT-BORNE DISEASES

"A fly and a flea and a skeeter and a louse
All lived together in a very dirty house.
The fly spread typhoid and the louse spread typhus, too,
And the people in that house were a very sickly crew."

The fact that this doggerel with its additional verses has been so widely copied bears witness to the general appreciation of the relation of insects to disease. If the public could be taught to act in line with its knowledge much would be accomplished in the safeguarding of the public health. The knowledge of the relation of flies and mosquitoes to disease is too general to require additional comment in an article whose purpose is to point out the less commonly known relations between insects and disease.

Bacteriologists, protozoölogists, and entomologists are coöperating today in an attempt to demonstrate further relations between insects and certain diseases of which the mode of transmission remains obscure. The recent outbreak of bubonic plague in New Orleans attracts our attention first to this disease. It has been known for several years that the rat flea is the chief agent in the transmission of plague, but the exact means by which infection takes place has been uncertain. The flea is known to imbibe the bacillus which causes plague when it sucks the blood of an infected animal, but how he infects the next victim remained a question. Among the methods suggested have been the ingestion of infected fleas by animals, simple mechanical transmission by the flea's proboscis, infection of the flea's salivary glands as in the case of the mosquito and malaria, and the rubbing of the infected feces of the flea into a wound caused by the bite or otherwise. Recently a commission of British investigators has made an intensive study of the subject and arrived at the following conclusion. The feces of the flea may transmit plague but contain relatively few bacteria and soon dry up, so that this method is uncommon. When a flea has fed on infected blood a rapid development of the bacilli takes place in the intercellular recesses of the proventriculus and this development proceeds to such an extent as to occlude the alimentary canal and prevent the entrance of additional blood to the stomach. The flea retains his appetite, however, and since his pumping device is in the pharynx is still able to suck blood, but the obstructing mass of bacteria prevents the blood from entering the stomach and consequently it regurgitates from the infected esophagus into the wound upon the cessation of sucking.

The flea may not starve as a result of this trouble, as the alimentary canal may later become open, but if the season is hot he may dry up before he can get any liquid. This is said to account for the fact that epidemics of plague in India are confined to the cool and moist season and are terminated by the onset of hot weather.

Leprosy is another disease of foreign origin found occasionally in the United States. It is caused by the *Bacillus lepræ*, an organism similar to the bacillus of tuberculosis, but the mode of transmission is unknown. Men have been known to live among lepers for years before becoming infected, but in other cases the transmission seems to take place almost immediately. Various insects have, from time to time, been suspected of carrying the disease but the most recent studies point to the head louse, *Pediculus capitis*, as the most probable agent, though the experiments have not yet been completed.

Typhus fever, known also as Brill's disease and in Mexico as tarbardillo, has decreased in prevalence with the spread of civilization and, except for sporadic cases, is now found only in overcrowded, filthy or unhygienic surroundings. Although the infective agent is apparently too large to pass through a Berkfeld filter it has not yet been identified, though recently a spirochete has been found to be present in many of the cases. It has been definitely shown that the head louse, *Pediculus capitis*, and the body louse, *Pediculus vestimenti*, are capable of trans-

mitting the disease and the flea is under suspicion, although lice appear to be the chief agent.

Relapsing fever has not been known in this country since the epidemic in New York and Philadelphia in 1869. It also is associated with insanitary conditions and is known to be transmitted by certain ticks, while various biting insects are suspected.

The cause of pellagra has been a subject for study for many years and it is now being investigated in various parts of the world. The buffalo gnat, *Simulium*, and other biting insects, such as the stable fly, *Stomoxys*, are being studied as possible carriers.

The bedbug is so generally disliked that attempts are continually being made to attach to it the stigma of being a disease carrier. Almost all infectious diseases have been charged to it at times but among the most common are relapsing fever, kala azar, tuberculosis, leprosy, typhoid, and syphilis. By its habits of biting and its association with humans it is fitted to carry disease, though it is not naturally associated with filth and lives comfortably in the cleanest surroundings. In this country, at least, it is quite certainly of no importance as a disease carrier, and as an index of decency and cleanliness it will probably rank far below the house fly when public opinion replaces prejudice by judgment. E. A. I.

RELATION OF TEETH AND EYES

A COMPARISON of the distance between the visible part of the eye lobes and the different development of the teeth in the human race, and in some of the mammals has thus far attracted little attention. It is apparent that where the carnivorous teeth are more prominent, as in cats and dogs, the eyes are a trifle farther apart than in the human race. In the rodents, such as rats, squirrels and beavers, the ocular lens is perceptibly placed on the side of the cranium. In the ruminants as well as a large number of other mammals with big molars, such as the horse, and so forth, up to the elephant, the eyes are separated in proportion to the size of the skull, being twice as much or more the distance apart as in the human genus.

It is not known whether or not the growth of the teeth appears in a certain order among the fishes, but with a few exceptions, as in the flounder, the eyes are placed one on each side of the compressed skull. This arrangement is almost similar to that of most birds, which lack dental apparatus if we exclude the serration of the bill in some of the parrot species. MAGNUS WESTERGREN.

BOMB-CARRYING DIRIGIBLES

IN VIEW of the possibility of offensive operations by Zeppelin airships, it may be of interest to observe that such a ship with full crew and fuel for a 1,300-mile trip may carry in addition to its usual ballast 1,600 pounds of bombs, and with fuel for an 800-mile trip 4,300 pounds of bombs. Using 200 pounds aërial torpedoes this allows from 8 to 20 units for each ship.

The striking velocity of such a bomb dropped from an altitude of 3,000 feet is 400 feet per second, and from 6,000 feet, 450 feet per second. This compares with a velocity of 2,000 feet per second for a projectile fired from a rifled gun and explains the lack of penetration of such aërial torpedoes. J. C. H.

ANTI-TYPHOID INOCULATION

THE value of the anti-typhoid inoculation is clearly shown by results in the United States army. Previous to the introduction of compulsory inoculation upon enlistment there was an average of 536 cases and 37 deaths each year. Last year, on the contrary, there were three cases and no deaths and two of these cases were men who had in some way escaped the inoculation. In no case of inoculation was there any record of any harm resulting from it. In the Spanish-American war one fifth of the American army contracted typhoid and 86 per cent. of the deaths among our soldiers in the war was caused by this disease.

E. A. I.

EQUILIBRIUM OF THE BODY

The position of the eyes in the fishes and birds indicates that their area of vision without moving the head must be considerably larger than ours, and their sense of equilibrium therefore different. The swimming act is performed by the pectoral fins and telson, while the dorsal and ventral fins regulate the balance of the body, which is to right or left, similar to that of the birds. That the balance is to right or left can be observed with especial ease in the sparrow, which comes in flocks, while on the ground, rushing or fighting for food, the wings are not always entirely extended; frequently one wing is almost resting on the chest for an instant while its mate is stretched to its full length.

In the human body the equilibrium is kept up somewhat differently, being more of a pendulum-like motion, to and fro, when walking on smooth, level ground, the sacrum describes a continuous horizontal wave line, and if a disturbance of balance occurs, the body usually falls forward, seldom to one side.

The oscillaria in the fishes and a few other marine animals can be regarded as annunciators which tell that something is passing outside. Whether the osseous labyrinth in our own ear is of the same character, or not, or whether it is merely an apparatus to aid in preserving equilibrium, is not known with certainty. Neither do we know whether we really see objects in their right position, or only seem to do so through habit, for they must be reflected upside down on the posterior part of the crystal lens of our eye.

Judging from the way pigeons, especially, tip their heads to one side to see where food is thrown on the ground, some lack in their forward vision is indicated and it would therefore seem that seeing the tips of both wings in the same sidewise glance were of more importance than direct forward vision. This ability to see both sides at once is an advantage which aviators do not possess.

Above a flat country, and an altitude of 10,000 feet, or more, the horizon is beneath the aviator and therefore his feelings about the right position of his aëroplane are lessened. Then, too, not passing any object, and being continually met by a strong wind, the airship seems to be standing perfectly still, and this produces a sleepy monotonousness which tends to make the aviator not always on his guard.

Magnus Westergren.

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STATUS OF THE TIN MINING INDUSTRY

THE UNITED STATES USES NEARLY HALF OF THE WORLD'S PRODUCTION OF THIS IMPORTANT METAL AND MINES PRACTICALLY NONE

BY WALDEMAR LINDGREN

SIX thousand years ago the Egyptian artisans of the fourth dynasty fashioned implements of bronze obtained by melting tin and copper together. Discoveries in the tombs of the eighteenth dynasty and excavations in the ancient city of Knossos on the island of Crete tell a similar story of industries flourishing 1500 to 2000 B.C. except that the weapons and ornaments are wrought with far greater skill. The history of tin thus goes back to the remotest antiquity. The records of most peoples tell us in fact of an early period in which an alloy of copper and tin was the principal metal used.

Through long centuries tin has been one of the most useful metals employed by man in his struggle towards civilization. Although, even at the present time, the production of tin does not approach that of iron, copper, lead and zinc, the metal still remains in a prominent industrial position. Its history is full of interesting features with sharp changes in the sources of production, in price and in practical use.

The metals occurring native, like gold and silver, or easily reduced from their ores, like tin and copper, were those first used by the races of antiquity. Copper, gold and silver occur in many countries, but tin is curiously and irregularly distributed. We know of no deposits of importance in southeastern Europe and adjacent parts of Asia. Most of the tin used in antiquity is said to have come from the "Cassiterides" or Tin Islands* whence it was brought out first by the Phœnicians, those early traders and explorers, at least as far back as twelve centuries B.C. Some of the metal no doubt came from the mines in Spain. How the ore was discovered and who first succeeded in smelting tin from it we do not know. Beyond doubt these "Tin Islands" were the Scilly Islands and adjoining parts of Cornwall. After some centuries the Phœnicians had to abandon their monopoly of the metal, and the deposits were worked by Greek and Roman miners.

Cornwall for a long time remained the one important source of tin, but later on, certainly in the sixteenth century, very similar deposits of tin ore were found in the Ore Mountains of Saxony. Altenberg, Zinnwald and other places furnished most of the tin needed by the Tuetonic races.

Compared with conditions today this mining proceeded upon an insignificant

* "Kassiteros," is the Greek word for tin. In Sanskrit it is "Kastira," in Arabic "Kasdir."

scale. It is estimated that the average annual production of tin in the thirteenth century was only about 300 tons. In the eighteenth century the same figure had risen to about 2,600 tons. This does not, however, represent the world's production for even at the earlier date mentioned tin was produced in China and bronzes were manufactured there but the output can hardly have been more than a few hundred tons per annum.

The next discovery of importance was made in the eighteenth century in the far East Indies, at localities probably long known by the natives, on the islands of Bangka and Billiton now owned by Holland, and in the Malay Peninsula, now known as the Federated Malay States. The production from these new fields soon entirely overshadowed the old fields of Cornwall and Saxony in which production, however, continued on a smaller scale. Even now about 5,000 tons of tin are annually recovered from the mines of Cornwall some of which have reached a depth of 3,000 feet.

The new continents opened by the white race were carefully searched by prospectors for tin as that metal began to assume an increased industrial importance. Every state of Australia was found to contain tin deposits in part associated with gold, and about 5,000 tons are now obtained from that region. Smaller deposits were opened in South Africa and recently Nigeria in Central Africa has entered the ranks of the producers with some 3,000 tons per annum. China has reopened her ancient tin mines of the Yunnan Province, and some thousand tons are added annually from that quarter.

Important as many of these sources are they seem insignificant in comparison with the great production from the Malay Peninsula which every year yields from 50,000 to 60,000 tons of the metal.

Far distant from the tropical jungles of the East Indies is the Bolivian district, where ore is mined on the high Plateau of the Andes in a wintry climate and at elevations of 16,000 feet. The Bolivian tin, known to some extent by the old Spanish miners, has recently acquired great importance, and the production is steadily rising. In 1913 about 28,000 tons were produced.

The singular and capricious distribution of tin ores has already been referred to. The United States is particularly unfortunate in this respect for in spite of careful prospecting no tin deposits of any consequence have yet been discovered within its domains. A few tons are produced from the bleak shores of Cape York Peninsula in Alaska; a little more comes from the Black Hills in South Dakota, and from the Appalachian Mountains in the Carolinas.

The total production of the world is for various reasons very difficult to estimate with exactness, but it has been steadily rising. Approximately 114,000 metric tons was the production in the world in 1908; in 1913 this had increased to about 125,000 tons.

The principal, and almost the only ore of tin, is the oxide. It forms a brown and inconspicuous mineral of great hardness, called cassiterite. This mineral is extremely resistant to the influence of weathering, and thus it easily accumulates in gravel beds lying below the outcrops of the veins. The only other mineral of importance is a complex sulphide of tin, copper and iron, which occurs in Bolivia and a few other places. The tin deposits form veins along rock fractures, or in crushed masses of rock, and some deposits have been followed by mining to a depth of several thousand feet. In such veins the cassiterite is accompanied by quartz and by a number of rare and characteristic minerals like wolframite containing tungsten, topaz containing fluorine, and tourmaline containing boron. Geologists hold that such tin-bearing deposits have been formed at high temperatures by vapors and solutions accompanying the intrusion of granite far below the surface of the earth. The veins, as they appear now, have been exposed by the gradual wearing down of the surface by erosion.

To ancient man, mining in hard rocks was a difficult problem, but the heavy tin mineral which occurred in abundance in some gravels, for instance, in Corn-

wall and in Saxony was easily recognized, and must have attracted attention at an early date. The cassiterite, or tin-stone is reduced to metal by charcoal in a hot fire, and we may easily imagine the accidental discovery of this reduction process.

For many years the tin-stone contained in gravels furnished a large part of the output of the world. As such beds can be worked cheaply a content of about two pounds per cubic yard of gravel may be sufficient for a profitable enterprise. At the present time the great deposits in the Federated Malay States and adjacent islands are almost wholly gravel beds, which are washed like gold placers for the recovery of the tin-stone. The prospectors are in large part Chinese, and until recently the work has been carried on in a primitive way. Now, however, hydraulic mining, that is, by a stream of water under pressure, and dredge mining, have been introduced into these regions.

On the other hand, the Bolivian deposits occur as veins, in slate and sandstone, and have been worked to a depth of 1,500 feet without showing noticeable impoverishment. The ore mined by the smaller concerns is rich, containing 10 per cent. or more of tin, but recently some enterprises have been started on a larger scale and on the basis of 3 per cent. ore. A peculiar feature is that silver, elsewhere absent from tin veins, often occurs in the ores. The grade of ore in the deep mines of Cornwall is much lower; it is said 1 to 1.5 per cent.

The use of tin in bronze for many purposes, such as implements, statues and ornaments, has already been mentioned. In medieval times bronze found an extensive use for church bells and later on, in the eighteenth century, tin mining received a further impetus by the use of bronze for a far less commendable purpose, that is, for the manufacture of cannons. The malleability of tin is an especially valuable property. Tin foil has been used for many hundred years, and no small amount of the metal enters into the production of this commodity. A still larger quantity is used for soldering and for various alloys, many of them easily fusible, and some used for bearings, etc. The low fusion point of tin (449° F.) is thus another property which commends the metal for manifold purposes in the foundry. Within the last hundred years many uses have been discovered for various tin compounds. Of these the chloride is particularly useful for many industrial processes.

All these uses are, however, subordinate, and if there were no demand outside of them the production of the metal would certainly not have risen to its present level. For the recent great consumption of tin the modest tin can is primarily responsible. Eighty thousand tons of the metal is annually required for the manufacture of these receptacles of sheet iron, covered by a thin coating of tin. In the last fifty years the demand for tin cans has risen enormously with the development of the preserving industry for provisions of all kinds, and last, though not least, for the shipment of petroleum all over the world.

Thus it happens that the United States, though leading in the canning industry, finds itself severely handicapped by a deplorable lack of tin deposits and is, broadly speaking, wholly dependent upon the production of the Federated Malay States and Bolivia. A protective tariff has made it possible to transfer the tin plate industry to the United States. We annually import about 50,000 short tons of tin as ingots. The figures vary sharply and suddenly. In 1907 and 1908, for instance, only 41,000 tons were imported, while a maximum was reached in 1912 when the importation amounted to 58,000 tons.

The price of tin has been subject to striking variations: a great deal of speculation and short selling is carried on, and the fluctuations are often extremely violent. The market price has varied from 13 cents per pound in 1896 to a maximum of 54 in 1913. During the last few years the price per pound in New York has varied between 25 and 50 cents. In January, 1908, the price was, for instance, 27 cents, while in January, 1913, it had advanced to 50 cents. The war which broke out in August, 1914, had an important influence on the market, but the price has

not increased greatly, but is, on the contrary, less than before. In the beginning of 1914 the price reached 40 cents, but later on dropped to 31 cents; in August there was a sudden rise to 50 cents, but in the last four months of the year the average price was only 31 to 33.5 cents. There was naturally, at first, a fear of shortage by the closing of the lanes of commerce and it will be remembered that one precious cargo of tin was sunk by the German cruiser *Emden* in the Indian Ocean. There is now little fear of the interruption of ocean communication, but instead the great consumption in Germany is suddenly checked, and it is not likely that the price will rise to high figures until we shall have peace once more.

This question of tin is a very serious matter for the United States. One hundred million pounds of tin, equivalent to about $40,000,000, is needed annually and must be purchased from foreign producers. There are no prospects, visible as yet, of domestic production of the metal. This granted, the most important problems relate to (1) control of foreign deposits by Americans; (2) domestic smelting of foreign ores, and (3) possible recovery of tin once used.

The control of the Malayan deposits is difficult and probably would be opposed by the colonial government. These gravel deposits are to the extent of 75 per cent. owned by Chinese firms who are able to carry on the work at very reasonable cost. Nevertheless, it is possible that we would be able to work these gravels to better advantage than the Chinese by the use of the most modern methods. The ownership of the Bolivian deposits is now in the hands of English, German and South American companies. Many attempts have been made by American capitalists to acquire control of these mines, the ores of which are of high grade, but so far these attempts have apparently not met with much success. The prices demanded for the mines are very high, and the costs of mining and reduction are considerable on account of an unfavorable climate and difficult transportation. Nevertheless, it seems probable that control will ultimately be acquired. Under normal conditions all of the Bolivian ore goes to Europe for reduction, one half of it to Germany, and the other half to England.

The larger part of the ores from the Federated Malay States is smelted locally and the tin exported. Therefore, it seemed possible to transfer the smelting of Malay concentrates to the United States, especially as the Standard Oil steamers returning from these parts could carry the ore at low rates. A smelter was accordingly built at Bayonne, N. J., but the tender industry was cruelly nipped in the bud by the Federated Malay States which, under British influence, promptly imposed a prohibitive export tax on concentrates. There seems to be no reason why Bolivian ores should not be brought to New York, via the Panama Canal, and smelted there, but it will be necessary to secure a firm hold on the ore supply before entering on plans for reduction works.

The principles of conservation clearly demand that as much tin as possible should be recovered from scraps and cans. As far as scraps from the manufacture of tinware this is, of course, done. A little more than one quarter, or about 14,000 tons, of the total imports of tin is recovered from scraps by electrolytic methods. The tin cans however, offer a far more serious problem. Their life is short and the tin used in them for coating of the sheet iron is very largely lost. It is easy of course to collect such used cans but the recovery of the tin is difficult and expensive owing to the organic matter and grease usually adhering to the articles. The discovery of a cheap process for the recovery of tin from this source would be highly desirable. Several small plants for this purpose are said to be in operation in England.

Another very important problem relates to possible substitutes for tin. Cans for oil might possibly be made from zinc coated (galvanized) sheet iron and the possibility of aluminum coated cans is perhaps not to be disregarded. Both zinc and aluminum are much cheaper than tin.

It is a long step from the time, thousands of years ago, when the Egyptian

artisans melted their bronzes and shaped their implements from copper and a few precious tons of tin, to the present time, when a hundred thousand tons are used to carry the world's commodities around the world. The importance and complexity of the problem of tin production, as far as the United States is concerned, has been pointed out in the preceding pages. It would seem that the time is ripe for an attempt to change the conditions which, in past years, have been so unfavorable to us.

ELEMENTS WITH SEVERAL ATOMIC WEIGHTS

Scientists of the present generation consider matter to be made up of small particles called molecules. These molecules are themselves composed of smaller bodies to which the name "atom" has been given. The atom has been defined as the smallest particle of an element that enters into combination with other atoms to form molecules.

Now just as the various elementary substances have different weights, so must the atoms of the individual elements have different weights, and it was natural that scientists should seek out a basis upon which to compare the relative weights of atoms. The actual weights of the atoms are of course too small for convenient comparison, and, as a result, the atom of the lightest known element, hydrogen, was arbitrarily chosen as the standard unit, and all the others were expressed in terms of this unit. The atomic weight of an element might, therefore, be defined as the relative weight of the atom compared to the weight of the atom of hydrogen as 1.

It was formerly supposed that each element had one, and only one, atomic weight, but it has been shown by recent investigation that lead from radio-active substances has a different atomic weight from that of the ordinary variety. Strange to relate, however, these different kinds of lead, if different in kind they are, have precisely the same chemical properties. That is, although the element itself may differ in atomic weight according to its source, the salts of the different varieties are identical. It has been suggested that elements, which have the same chemical properties but different atomic weights, such as lead has, should be called isotopes.

Many scientists have long been waiting to be shown that all the eighty odd elements are composed of one, or at least a few simple substances. The new discovery may be a step in this direction.

E. B. S.

TAKING UP THE RECOIL

The quick-firing field gun used by the French and British is equipped with a most ingenious device for taking up the recoil. When it is fired the gun slides along guides on the top of a steel box, called the cradle. Inside of the cradle, and attached to the gun, is a piston, which is driven by the recoil into a cylinder filled with glycerin. The glycerin is forced through narrow channels into a reservoir full of compressed air, which it further compresses. This friction brings the gun to rest after it has recoiled and then the expansion of the compressed air forces the glycerin back into piston and returns the gun to the firing position once more.

A DELICATE INSTRUMENT

In the development of apparatus for the delicate work of measuring the radiation from the stars, which is being carried on by the United States Bureau of Standards, an instrument has been invented which is so sensitive that, in combination with a three-foot reflecting telescope, it will give a galvanometer deflection of one millimeter when exposed to the heat of a lighted candle placed at a distance of fifty-three miles. In order, however, to do much valuable work in stellar spectral energy curves, an instrument must be developed that will be sufficiently sensitive to detect the radiation from a candle placed at a distance of 500 miles away from it.

NEW DISCOVERIES IN OIL REFINING

THREE TIMELY AND ENRICHING DISCOVERIES THAT CONSERVE AN IMPORTANT RESOURCE AND HINT AT THE ORIGIN OF CRUDE PETROLEUM IN THE EARTH

BY ELLWOOD B. SPEAR

Gasoline, naphtha, benzine, kerosene, most of our lubricating oils, vaseline and paraffin, are obtained by distilling crude petroleum. As is well known, this substance is found in enormous quantities in the earth, and the United States and Russia are the chief producers. Twenty years ago kerosene was the most sought for of these products, while we had a surplus of gasoline. With the advent of the internal combustion engine, as a means of power, especially the enormous output of automobiles of recent years, gasoline has become the all-important member of this series. Until a year or so ago the maximum amount of gasoline obtainable from crude petroleum was comparatively small, *i. e.*, less than 7 per cent. The exact amount differed with the different varieties of the crude material. The price was steadily increasing, and it became a serious question whether the internal combustion engine could long be employed in the future as a means of power, because of the high cost of the fuel, gasoline. Happily recent discoveries have changed the entire aspect of the affair. The price of gasoline has greatly decreased and auto owners may breathe easily once more.

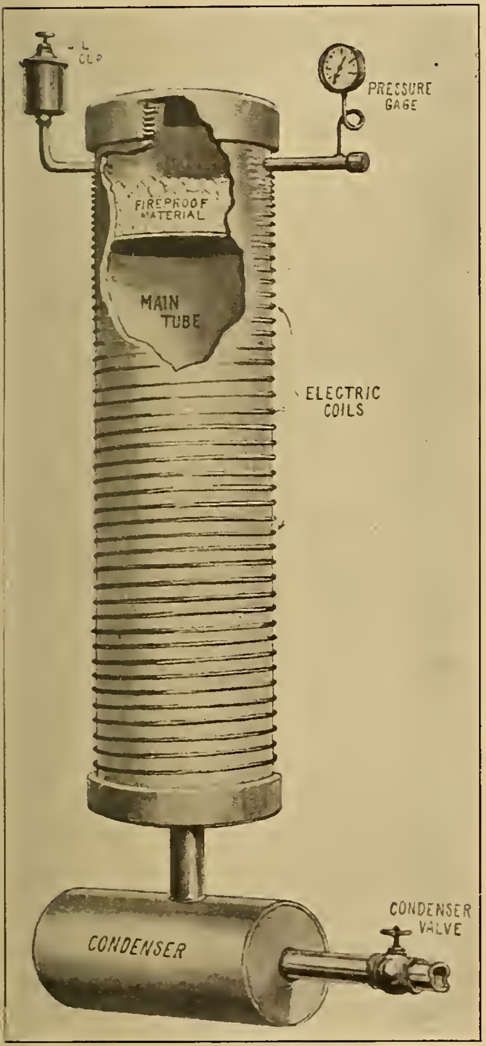
The first of these discoveries, as set forth by the Burton patent, has already proved itself of great commercial value and is at present employed by the Standard Oil Company. Until the introduction of this process crude petroleum was distilled either at atmospheric or under slightly increased pressure. The vapors obtained were suddenly cooled and condensed at the pressure of the air. Herein, however, lay the mistake; for Burton discovered that if the distillation was carried out under pressure and the vapors were condensed also under pressure, the yield of gasoline was increased two to three-fold. It is needless to say that this is of very great importance for the future of the gasoline engine.

Two other startling discoveries, one by Rittman and the other by Snelling, promise to become of enormous importance to our industries. It should be noted, however, that both these discoverers warn us against forming hasty conclusions, such as we have recently been treated to in the newspaper reports of these discoveries. The processes of both Rittman and Snelling are still in the experimental stage, and while they may be feasible in the laboratory, it remains to be proved that they are practicable on a commercial scale.

It has long been noted that crude petroleum, if allowed to fall on hot bricks, was partially broken down into gasoline and other closely allied substances. This process is employed by producers of illuminating gas and is commercially known as "cracking." Rittman has discovered that if this cracking process is carried out where the oil is in the form of a gas and under great pressure, *i. e.*, 500 pounds per square inch, the amount of gasoline obtainable is greatly increased. Nor is this all. Benzol and toluol, the raw materials from which dyes and the most valuable explosives are made, are also formed during the cracking process.

Rittman's laboratory apparatus is shown in figure 1. The oil is allowed to drop from the oil cup upon a heated, fireproof material, as seen in the cut. The gases thus formed pass into the main tube. This is heated by electric coils, and the higher temperature causes an increase in the pressure. The cracking process takes place in the main tube under these conditions. The products are condensed in

the tube at the bottom of the apparatus. (Marked "Condenser" in the cut.)



The experimental apparatus of Dr. Rittman—Courtesy of the *Scientific American*

It is pleasing to note that Rittman's process is to be patented and dedicated to the American people, so that small and independent oil companies may compete with the larger and more wealthy concerns.

Snelling's discovery, if it turns out to be practicable commercially, is even more important than either that of Burton or Rittman. Snelling's experiments indicate that not only is more gasoline obtained when the cracking takes place in the vapor instead of the liquid phase, but also that crude petroleum is a product into which each one of the substances mentioned in the first paragraph of this article may be changed at will. That is to say, after all the gasoline possible has been extracted by the Rittman and Burton processes, the remaining substances, paraffin, vaseline, lubricating oils, etc., may be introduced into Snelling's apparatus and a crude petroleum again formed which differs from the original crude petroleum only in that the artificial product does not contain any clay. This artificial petroleum is again capable of treatment by the Rittman or Burton process and more gasoline can be distilled off. By repeated distillation and "repetrolization," to coin a new term, Snelling has succeeded in changing a very much larger proportion of the total original crude petroleum into gasoline than can be done by the Rittman or Burton process alone.

Snelling's important discovery throws some light on the origin of crude petroleum in the earth's interior. All the above mentioned compounds, gasoline, kerosene, etc., are combinations of hydrogen and carbon. If any one of these compounds is formed in the earth under suitable conditions of temperature and pressure, it will be converted into crude petroleum. It of course remains to be seen whether such a deduction is entirely justifiable or not.

THE GYRO-COMPASS IN THE NAVY

The Sperry gyro-compass, which was described by Mr. Sperry in the first issue of Science Conspectus five years ago, when it was in an experimental state, has now been placed on twenty battleships, one armored cruiser and fifteen submarines of the United States navy. It has been decided to install master gyro-compasses in duplicate on all battleships of the *Delaware* class and later. Special instruction is given to officers and men who have the care of these compasses.

THE ORIGIN OF PEARLS

In an article in *The Popular Science Monthly* a year or two ago Professor Edwards of the University of Southern California had an article on "The Abalones of California." A paragraph in the article on pearls is interesting:

"The origin of pearls has been a matter for speculation during many centuries. As related in ancient folklore, the pearl oyster, rising to the surface of the sea in the early morning, opens wide the valves of its shell, so that dewdrops may fall within. Under the influence of the air and warm sunshine lustrous pearls develop from these glistening drops of dew. The pearls are white when the weather is fair, but dark if it is cloudy. This belief was held from the first to the fifteenth century, when the theory was advanced that the eggs of the pearl oyster serve as nuclei for pearls.

"About the middle of the sixteenth century Rondelet concluded that pearls form from diseased concretions, and then, in 1600, Anselmus de Boot demonstrated that they are made of the same substance as the shell. Réaumur, in 1717, showed by aid of the microscope that the pearl is composed of concentric layers of nacre, which we now know serve as minute prisms to split up the white light into the rainbow tints so beautiful when reflected from the surface of the pearl. In the middle of the nineteenth century from an investigation of the freshwater mussels of Turin Lake, Filippe proved that the stimulus for pearl formation in that species is a trematode worm.

"Other naturalists, Küchenmeister, 1856; Möbius, 1857; Kelaart and Humbert, 1859; Garner, 1871, Dubois, 1901, and Giard, 1903, have contributed to our knowledge of the origin of pearls from parasitic nuclei. In 1902, Jameson traced the life history of a *Distomum* from its first host, a duck, to a clam, as its second host, and he succeeded in inoculating the edible mussel, *Mytilus*, by placing it with parasitically infected mollusks, and thus artificially induced the formation of pearls.

"Herdman, in 1903, found in the pearl oysters of Ceylon that a tapeworm larval cyst may become a pearl nucleus, or that in some cases the secretions may be deposited around sand grains, bits of mud, or a fish or some other small animal, in pockets of the mantle epidermis, or again about calco-spherules near the muscle insertions. The surface finally becomes polished, or takes the "orient," and thus reflects the opaline and nacreous tints so highly prized."

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EDUCATIONAL DEVELOPMENT IN AGRICULTURE

WHAT IS BEING DONE TO EDUCATE THE FARMER THROUGH AGRICULTURAL COLLEGES, EXTENSION COURSES, AND MORE RECENTLY THROUGH THE PUBLIC SCHOOLS

L. S. HAWKINS

During the past quarter of a century agriculture has had an extraordinary development in the United States. Money and efforts have not been spared in the search for better methods and practices or in getting the facts to farmers. Experiment stations, colleges of agriculture, state departments of agriculture and the United States Department of Agriculture have been the important agencies in this work.

Although several states early started experiment stations, the movement became national in 1887 when, through the Experiment Station Act or Hatch Act, Congress made available to each state an annual appropriation of $15,000. In 1906 the second Experiment Station Act or Adams Act, duplicated this appropriation. The early work of the experiment stations was largely policing—analysis and control of fertilizers, feeding-stuffs and seeds, enforcing plant and animal quarantine, etc. Much of this work is still done by them but it is in the field of research that they have made and are making the greatest contribution to the forward march of agriculture. The stations publish the results of their investigations in bulletins available to the farmers. These publications number over seven hundred a year and reach more than a million people. The subjects discussed cover a wide range of science and practice and the information is the basis of present day agriculture.

While the stations annually send out hundreds of the staff members to assist at farmers' institutes, local organization meetings, etc., it may be safely said that the great field of the experiment stations is getting together a reliable and available body of knowledge concerning the agriculture of their respective states.

In 1862 Congress, through the first Morrill Act, donated public land to the several states and territories which might provide colleges for the benefit of agriculture and the mechanic arts. Institutions receiving the benefit of this and subsequent acts are now in operation in all the states and territories except Alaska.

"College * instruction in agriculture is given in the colleges and universities receiving the benefits of the acts of Congress of July 2, 1862, August 30, 1890, and March 4, 1907, which are now in operation in all the states and territories except Alaska. The total number of these institutions is 68, of which 65 maintain courses of instruction in agriculture. In 23 states the agricultural colleges are departments of the state universities. In 16 states and territories separate institutions, having courses in agriculture, are maintained for the colored race. All of the agricultural colleges for white persons and several of those for negroes offer four-year courses in agriculture and its related sciences leading to bachelors' degrees, and many provide for graduate study. About 60 of these institutions also provide special, short, or correspondence courses in the different branches of agriculture, including agronomy, horticulture, animal husbandry, poultry raising, cheese making, dairying, sugar making, rural engineering, farm mechanics, and other technical subjects. Officers of the agricultural colleges engage quite largely in conducting farmers' institutes and various other forms of college extension. The agricultural experiment stations, with very few exceptions, are departments of the agricultural colleges. The total number of persons engaged in the work of educa-

* From Year Book of United States Department of Agriculture.

tion and research in the land-grant colleges and the experiment stations in 1913 was 7,651; the number of students (white) in interior courses in the colleges of agriculture and mechanic arts, 47,216; the total number of students in the whole institutions, 88,408 (not including students in correspondence courses and extension schools); the number of students (white) in the four-year college courses in agriculture, 12,462; the total number of

A fourteen-year-old boy and the poultry house built by him in connection with his home project

students in the institutions for negroes, 8,561, of whom 1,795 were enrolled in agricultural courses. With a few exceptions, each of these colleges offers free tuition to residents of the state in which it is located. In the excepted cases scholarships are open to promising and energetic students, and in all opportunities are found for some to earn part of their expenses by their own labor. The expenses are from $125 to $300 for the school year."

These are known as the land-grant colleges. The second Morrill Act in 1890 provided for an annual apportionment of $25,000 to each state for the support of institutions maintained in accordance with the first act, and the Nelson Amendment of 1907 increased the $25,000 to $50,000.

The colleges of agriculture stand for the whole range of country life in both its productive and social phases. In most states the experiment station is located at the land-grant college and takes care of a large part of the investigation work. This leaves the college proper free to devote its energies to the task of organizing the results of research and to teaching. The interior activities in teaching include post-graduate, four-year, two-year, one-year and short courses of instruction for between fifty and sixty thousand students. It is in the field of extension or exterior teaching that the most noteworthy recent development has taken place. Extension work has been described as "comprising all those activities that are not of academic kind and that aim to reach the people and their problems in the places where the problems are. It is conducted mostly away from the institution. It differs from the regular forms of university extension in its purpose to aid the person at home with his special questions, one person at a time." The earlier forms of extension work consisted in sending out bulletins or reading course literature and holding meetings at which representatives of the college and experiment station talked to the people. This work is still being done but everywhere effort is being made to secure local organization. The earlier efforts of extension were paternalistic but the modern efforts are toward fitting the people to progress by showing them how to do things for themselves. Coöperative experiments are being conducted. The college plans the experiment, in some instances furnishes the seed, fertilizer, etc., oversees the starting of the work and analyzes the results. But the farmer does the work and the experiment is worked out on his own farm. Field demonstrations are conducted at which are present all the farmers of the neighborhood who are interested. Traveling schools of from two days to two weeks' duration, in charge of persons specially trained for the work, give systematic instruction in the various branches of agriculture of most interest locally. Farm trains with the best equipment for teaching carry educational impulse and the latest information to thousands. Correspondence and reading courses give individual instruction along all lines of agriculture to many unable to attend any of the schools. The latest movement in

A field laboratory excercise—barrel packing apples

extension work is the location of a resident agent in each county. This agent is variously named: farm bureau agent, county agent, local agricultural representative, etc. His function is to coördinate the various agricultural activities of the county in which he works and to act as the local representative of the college of agriculture and the United States Department of Agriculture in gathering and disseminating information. Thus far these agents have been greatly handicapped by the fact that the farmers look upon them as men who should devise some solution for all their individual problems. Under the operation of the Smith-Lever law which makes liberal provisions for national aid to extension activities, the land-grant colleges will make even greater efforts to carry new ideas direct to the farmer.

State organizations for agriculture are diverse in aim and methods. The usual designations for these organizations are: state departments of agriculture and state boards of agriculture. They have as a general aim the promotion of agricultural interests. In some states they receive large appropriations from the state for performing police duties and carrying on extension activities, while in other states they receive small appropriations and have nominal duties.

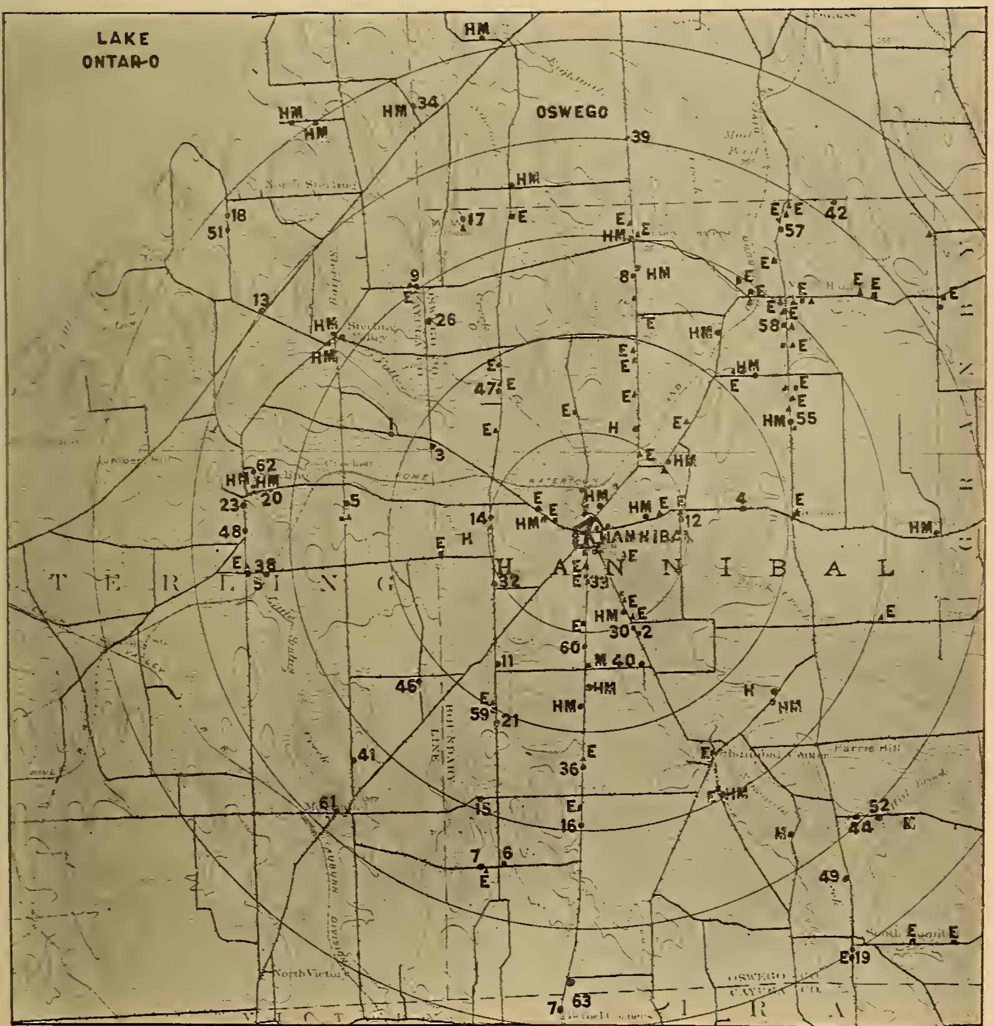
The United States Department of Agriculture was created in 1862. Previous to this time the commissioner of patents looked after national agricultural affairs. In 1898 this department employed 2,500 people and received an appropriation of about $2,500,000 while fifteen years later it had about 15,000 employees and received in round numbers an appropriation of $24,000,000. Of this money approximately $15,000,000 was spent for policing, $8,000,000 for research and investigation and $1,000,000 for extension.

The office of experiment stations in this department supervises the work of all the experiment stations, and to some extent the work of the land-grant colleges. The department publishes technical abstracts of all experiment station literature

Hamburg high school class studying poultry. An eighteen-day laying contest between three white wyandottes, three white leghorns and three white orpingtons was conducted in these pens. The contest resulted in a victory for the orpingtons with a total of thirty-eight eggs

and also many bulletins founded on investigations carried on by its employees on a great range of subjects. These investigations are of a regional rather than a local character and do not duplicate the work of the stations. The extension activities of the department are constantly increasing but are now for the most part carried on through or in coöperation with the land-grant colleges and state departments of agriculture.

With all these efforts to assist the adult who is engaged in the business of farming there has lately grown up a sentiment in favor of offering to the boy who is still in school an opportunity to fit himself for this business should he so desire. As a consequence, various types of secondary schools of agriculture have come into existence. In general these schools may be divided into two classes: (1) separate institutions which maintain only courses in agriculture. They usually own a farm, barns, flocks, herds, etc., and are so costly that relatively few may be maintained in a single state. This means that the students must leave home. The parents lose the work of the boy from "chores" and the boy loses the influence of the home; (2) courses in agriculture in established high schools. These schools serve comparatively small communities and the pupils go home each night. A small community means few pupils and thus there is need for but one or two teachers of agriculture in each school. The cost is low, therefore many of the schools may be established. Since the pupils live at home on farms, no school farms or animals are necessary though small plots are often maintained for demonstration purposes. Neighboring herds, barns, flocks and crops are used for the purpose of laboratory and field instruction. Perhaps the most significant phase of this movement is the fact that each boy who studies agriculture in school works out on the home farm a project along the line of each year's study in school. The teachers are hired for the full year including the summer vacation and when the schools are closed, spend the time in visiting the home projects of the pupils, collecting material for the work of the



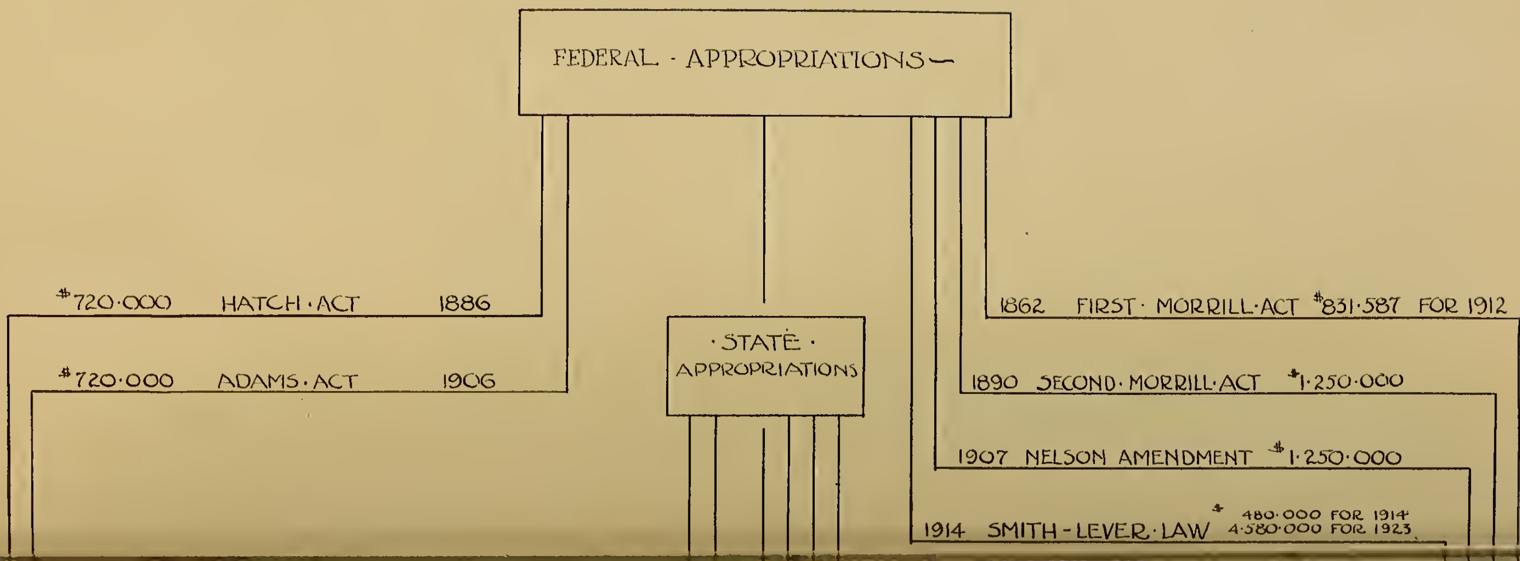
Agriculture and Home-making in the High School at Hannibal, N. Y.

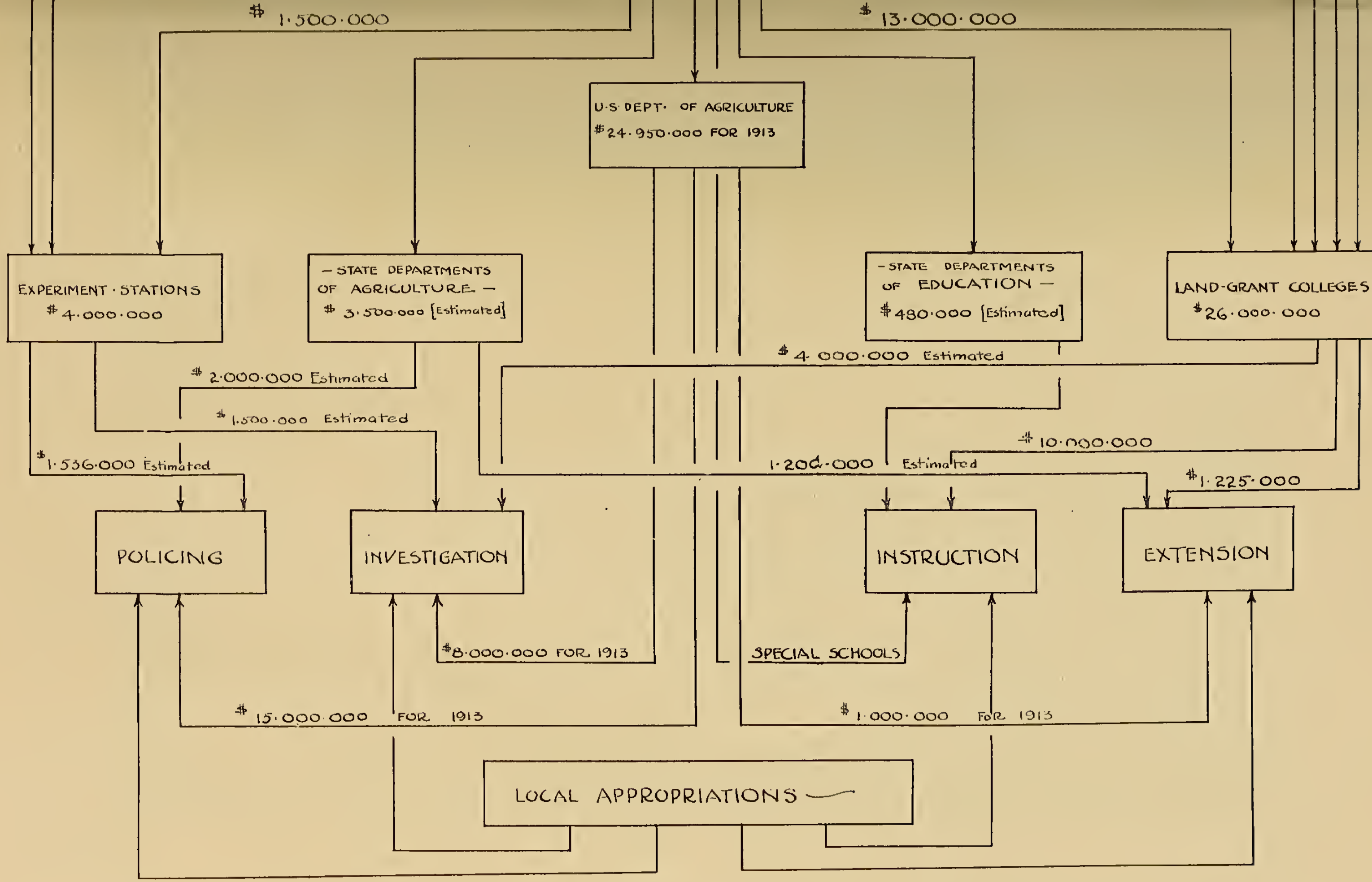
Figures indicate location of homes of pupils in agriculture classes. H. M. indicates location of homes of pupils in home-making classes. E. indicates local coöperation, field demonstrations, use of materials, class visits, etc. The radius of the inner circle is one mile and the outer one five miles.

following year and assisting the farmers of the community when called upon to do so. In these small circles a teacher of agriculture comes into close contact with the people and their business. Experience has shown that the best extension work can be done by persons thus brought into close contact with the people. County agents, colleges of agriculture and the United States Department of Agriculture are working in hearty coöperation with these schools. Many of these schools are conducting evening courses for farmers.

It is to be hoped that Congress, in view of all the money now being expended for adult extension work and college instruction, will see the way clear to adopt the recommendations of the Commission on National Aid to Vocational Education and do something to further the work with boys still in school.

AGRICULTURAL · EDUCATION · & · APPROPRIATIONS · IN THE · UNITED STATES





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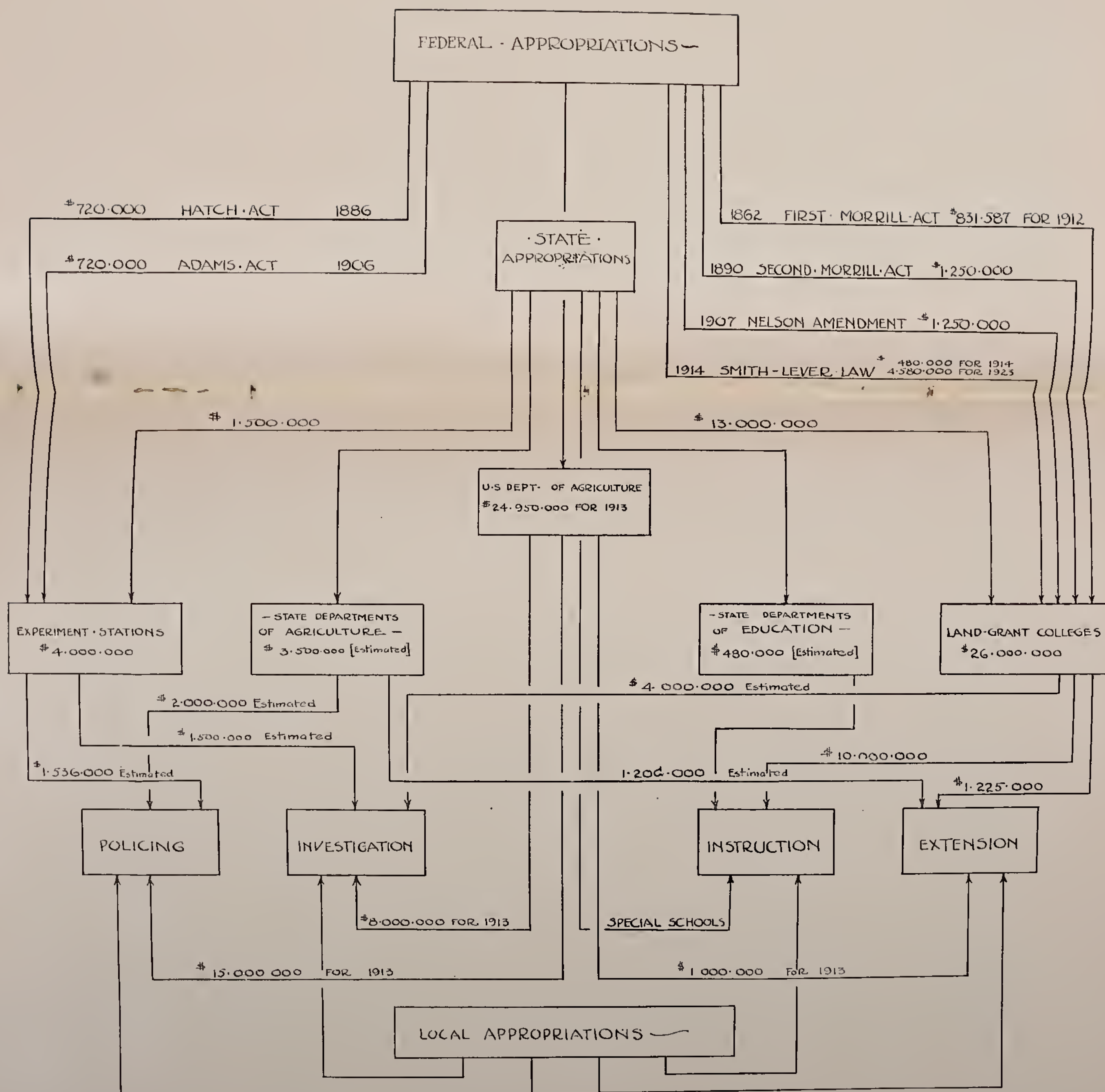
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LOCAL APPROPRIATIONS —

WHEN REPTILES RULED THE EARTH*

BEFORE THE ASCENDENCY OF MAMMALS HUGE SAURIANS OF REMARKABLE APPEARANCE, THICKLY SETTLED MANY PORTIONS OF THE WORLD

BY HERVEY W. SHIMER

One of the interesting facts that a study of fossils reveals is that through the long course of the geological ages there has been much shifting in the position of dominance among living beings. It is probable that for a long time, in the far-back, early history of the earth, only vegetable life, and that of a lowly seaweed sort, was present in the oceans. Following this plant-life and dependent upon it, evolved the vast panorama of invertebrate life, and for millions of years the seashores swarmed with the mighty hordes of mollusks and starfishes and their kin.

All of the earlier part of the Paleozoic, the second of the four great divisions of the earth's history, is known as the age of invertebrates. Then in the later Paleozoic, backboned animals appeared for the first time and the seas were dominated by the fishes. The amphibians, the group of vertebrates next higher in evolution to the fishes, appeared somewhat later in the Paleozoic, but have never assumed a commanding place in the life of the earth. It was, however, to the present unimportant class of reptiles that the mastership of land and water fell during the Mesozoic, the third of the eras of earth-history. This mastership was held during all of the Mesozoic,—the age of reptiles, and it was only in the succeeding era, the Cenozoic, that mammals assumed their present superiority.

There are at present more than four thousand species of reptiles, falling into four groups,—the snakes and lizards, the crocodiles, the turtles, the Sphenodon or tuatera. Though so different in habits and forms, these possess the common characters embraced in the definition of a reptile as "a cold-blooded, backboned animal which breathes air throughout life." This definition distinguishes reptiles from the warm-blooded mammals and birds on the one hand and from the cold-blooded fishes and amphibians, which are water-breathers during the whole or a part of their existence, on the other.

The amount of knowledge which we possess of the appearance and habits of extinct reptiles, slowly built up during long years of patient collecting and study of their fossil remains, is truly amazing. The chief record is naturally their skeletons, usually found in scattered parts, but occasionally preserved as a whole. The flesh is, of course, never petrified, but the form of the living animal may be closely approximated from the study of the bones. Sometimes the scaly skin is preserved in a carbonized condition, while even its color pattern is indicated in the residue of carbon pigment. Fossil stomach contents reveal something of the food habits, while the bony remains of unhatched young and the frequent discovery of bones which have been injured and mended during life, give vivid pictures of their conditions of life.

The earliest reptiles are known from the Coal Measure times of Ohio; by the beginning of the Permian (uppermost Paleozoic) there were many and diverse kinds—water dwellers, marsh dwellers, land dwellers, and even those that could climb trees. Though many genera are known from the Permian of the United States, the most remarkable reptilian fauna of that time lived in South Africa and Russia, some of the African forms

*Largely adapted from "Water Reptiles of the Past and Present," by S. W. Williston, professor of paleontology in the University of Chicago; published by the University of Chicago Press, 1914.

View over the sea that covered Kansas in upper Cretaceous times. In the foreground a plesiosaur, a reptile characterized by the longest neck of any known creature of past or present times, reaching, in the specimen figured, a length of twenty-three feet and possessing seventy-six vetebræ. Likewise in the foreground one of the diving birds of the time, three feet high. In the air and on the rocks are pterosaurs, huge, flying reptiles. The short-necked reptile farther out in the water is an ichthyosaur, in shape and habits much like the dolphin, a swimming mammal of the present seas. Restoration by Williston.

A mosasaur from the chalk deposits of Kansas. These swimming lizards existed by thousands in the Cretaceous sea, not only of that region but of many other parts of North America, of Europe, New Zealand, and South America. They varied in length from ten to forty feet. That they were carnivorous is shown by their large jaws and teeth; they were probably the only water reptiles that would have been dangerous to man had he lived at the time of these ancient seas Restoration by Williston.

merging into the mammals of the next succeeding period. It was, however, in the Jurassic and Cretaceous periods of the Mesozoic that reptiles attained their greatest prosperity and diversity, dwindling away at the beginning of the Cenozoic to their present unimportant position in the world's fauna, thus closing the Age of Reptiles at the beginning of the Age of Mammals.

Much of the marvelous and diverse development of ancient reptiles took place along the shores and in the waters of the Cretaceous sea of western North America. During the later Mesozoic this sea extended from the Gulf of Mexico on the south to the Arctic Ocean on the north, dividing the continent into two bodies of land. It covered the present site of the Rocky Mountains and extended to the east over quite a part of the present Great Plains. Into it slowly fell sediment, composed of the microscopic shells of animals and plants, and formed masses of almost pure chalk. In these sediments were buried and preserved the remains of the sea life and those of the shore and land, which were brought in by the rivers.

During the succeeding millions of years this interior sea dried up and its bottom was raised far above the present level of the ocean. In these consolidated sediments fossil hunters now find the bones of the ancient animals buried so long ago in the bottom of the Cretaceous sea. The beds of the Niobrara chalk in western Kansas, for example, have furnished thousands of specimens, — mosasaurs, pterosaurs, plesiosaurs, and turtles.

Perhaps the most marvelous of all reptiles are those found in the uppermost Cretaceous beds of America, from Colorado, Wyoming and Montana, and from near Edmonton in Canada. These were the race of dinosaurs, huge beasts, walking on two feet or aquatic forms of enormous size. Many were furnished with extravagant horns and spines.

The flying reptiles of Cretaceous times had bird-like bills and have been sometimes called the kingfishers of the Cretaceous seas.

MELTING POINT OF COPPER ALLOYS

As very little information on the melting points of commercial brasses and bronzes can be found in either scientific or technical literature, tests of a few typical alloys were made by H. W. Gillett and A. B. Norton of the United States Bureau of Mines. The results are summarized as follows:

Alloy	Approximate Composition				Melting Point	
	Copper	Zinc	Tin	Lead	°Cent.	°Fahr.
Gun metal	88	2	10		995	1825
Leaded gun metal	85½	2	9½	3	980	1795
Red brass	85	5	5	5	970	1780
Low-grade red brass	82	10	3	5	980	1795
Leaded bronze	80		10	10	945	1735
Bronze with zinc	85	5	10		980	1795
Half-yellow-half-red	75	20	2	3	920	1690
Cast yellow brass	67	31		2	895	1645
Naval brass	61½	37	1½		855	1570
Manganese bronze					870	1600

The melting point given is the "liquidus," or point where the alloy is completely molten. The temperatures are thought to be accurate within plus or minus 10° C. or plus or minus 20° F.

CARING FOR INNER TUBES

The following instructions as to how best to care for inner tubes comes from a German rubber manufacturer, who furnished the information to the dealers in tubes of his manufacture. His advice as to the best way to preserve the tubes is to blow them up to the pressure of an ordinary rubber ball, hang them on one or two thick, round poles in a darkened room in which a dish of unslacked lime and one of an ammonia solution are placed in the corners on the floor. These precautions keep the air free from destructive acids and retards the process of vulcanization in the tubes.

PLANTS IN HIGH ALTITUDES

Investigations show that there are at least eighty-six species of flowering plants living above the snow line in the Tyrolese Alps. Six of these occur over 1,500 feet above the snow line; one species, the glacial Ranunculus, was met with at a height of over 12,000 feet above sea level.

ULTRA VIOLET LIGHT AND WATER STERILIZATION

THE NATURE AND PROPERTIES OF ULTRA-VIOLET LIGHT AND THE METHODS OF PRODUCING IT—HOW IT IS BEING UTILIZED IN WATER PURIFICATION

BY JOHN F. NORTON

Light consists of electromagnetic waves propagated through the ether. These waves have a transverse motion and a very high frequency. Each kind of light, that is each color, has its characteristic frequency and wave length. For example, in yellow light there may be 508 billions of vibrations per second and the wave length be 589 $\mu\mu$—23.3 millionths of an inch. Light waves giving a violet sensation may vibrate at the rate of 763 billion times per second and have a wave length of 393 $\mu\mu$. Since all kinds of light travel at the same rate the higher the frequency, the shorter must be the wave length. White light is composed of a very great variety of waves and is therefore heterogeneous in character.

If we take homogeneous light,—that is light consisting of waves of only one length,—and pass it from one medium into another of a different density, as from air into a glass prism, the direction of the path of the beam is changed, or as we call it, refracted. This *fact* of refraction has been known for a very long time, being a part of the very small optical knowledge before Newton. In about 1621 Snell formulated the *law* governing refraction. Figure 1 will serve to illustrate. Let *CBK* represent the surface between the two media, and *AB* the beam of incident light. If *EF* is drawn perpendicular to *CBK* and in the plane *ABC*, the angle *i* will be the "angle of incidence." After passing through *CBK* the beam is refracted along the line *BH*, *r* being the "angle of refraction."

According to Snell's law $\sin i = \mu \sin r$. This quantity (not to be confused with the sign $\mu\mu$ used before), *i. e.*, the ratio of the sin of the angle of incidence to the sin of the angle of refraction, is called the index of refraction, and is dependent, for any one kind of light, on the media used for the experiment. But lights of different wave lengths are refracted to different degrees,—the shorter the wave length the greater the refraction.

Suppose that white light is passed from the air into a prism. Each wave will be refracted according to its own particular

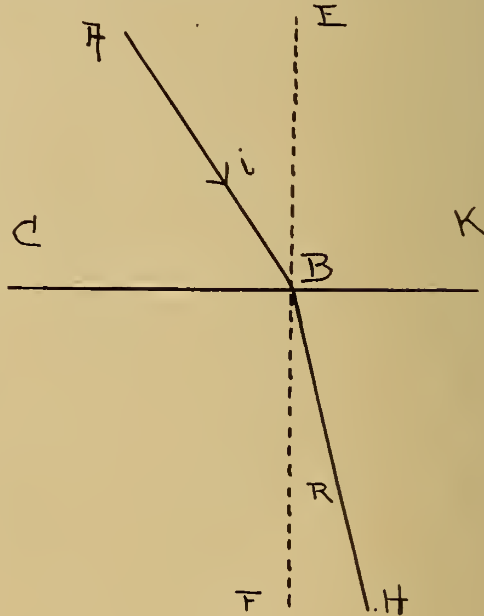

Figure 1

amount,—the waves giving the sensation of red the least and those giving the sensation of violet the most. The white light is thus broken up, or "dispersed," and we have the well-known spectrum.

This spectrum apparently has two fairly sharp ends, but since only certain very definite light waves affect our eyes, these ends are only apparent, and the visible spectrum is but part of the real

spectrum. The light waves toward the red end are the longer, the limit of visibility being about 760 $\mu\mu$. Out beyond this lie the infra-red or heat waves. At the other end of the spectrum the limit of visibility is reached at about 371 $\mu\mu$. But beyond this visible violet light is the most interesting field of all, that containing the chemical, actinic or ultraviolet rays.

This field contains rays having wave lengths from the end of the visible spectrum to about 120 $\mu\mu$, the shortest which have been measured. Ultraviolet light has very great chemical activity. For example, it has very strong action on the silver salts used on photographic plates, and this has led to the use of photography in the study of the invisible violet spectrum. The rays will decompose potassium iodide, which can be easily shown by dipping some filter paper in a starch solution and then in a potassium iodide solution. If the paper is then exposed to ultraviolet light it turns blue immediately, showing that iodine had been iberated. The rays are also active in causing chemical combination,—a mixture of the gases hydrogen and chlorine instantly exploding under their influence, —and certain organic reactions may be made to take place much more quickly than under ordinary circumstances. The light causes fluorescence of uranium glass and of quinine and the luminescence of calcium or barium sulphides. Finally, ultraviolet light has a very distinct and important effect on living matter, and particularly on the lower forms of life, such as the bacteria. More about this later.

One physical property of these rays which it is necessary to mention is that of being readily absorbed by any medium through which they are passing, the shorter rays being more easily absorbed, the actual numerical amount being a function of the medium used. Air absorbs some of the rays, so that the sunlight as it comes to us contains only part of the known field of ultraviolet light. Other gases absorb to greater or smaller amounts.

Sunlight is therefore one source of ultraviolet light. The common carbon arc lamp gives a better supply, but the most satisfactory and practical method is by means of the mercury-vapor, better known as the Cooper-Hewitt lamp. Most of us are familiar with this light, as it is seen in post offices and to some extent in other offices and drawing rooms. The light comes from mercury vapor maintained at incandescence by an electric current. We have stated that the rays are quite easily absorbed. In the ordinary Cooper-Hewitt lamp, most of the very short rays are absorbed by the glass. If the glass is replaced by quartz, a much larger amount of the very active light passes through and is available for use. These mercury-vapor-quartz lamps are therefore the most desirable for practical purposes.

One other method of producing ultraviolet light is at least of some scientific interest. If a glass tube is filled with some such gas as oxygen, nitrogen, carbon monoxide or hydrogen, then most of the gas removed by a vacuum pump, and the end sealed, the tube will contain a small amount of the gas under a greatly reduced pressure. If the tube is fitted with proper terminals and connections, an electric discharge may be passed through the gas causing a luminescence containing the shortest light waves which have ever been studied. These tubes are called Geissler tubes. The region of the spectrum containing these very shortest waves has been called the "Schumann Region," in honor of Victor Schumann who was the pioneer in its investigation.

Schumann was born in Leipzig in 1841, was educated in the schools of that city and of Chemnitz, and was early employed in the design and manufacture of machinery, in which trade he developed great mechanical skill. When about forty years old he became intensely interested in physical science and particularly in photography, finally giving up business in order to devote his entire attention to spectrum analysis and the study of ultraviolet light. The most important instrument used in working with invisible rays is the photographic plate. Schumann developed a very sensitive emul-

sion for these plates and was able to photograph spectra containing rays as short as 120 $\mu\mu$, the shortest ever accurately measured. He obtained the light from Geissler tubes, each fitted with a window made of fluorite, as this was found to absorb less rays than any other available material. After an investigation concerning the absorption of ultraviolet light by gases, and finding that oxygen, one of the constituents of air, had rather high absorptive power for the very short rays, Schumann undertook to overcome this by means of his "vacuum spectrometer," an instrument similar to a spectroscope with a photographic plate in place of the eye piece. The whole thing was made so air tight that the tube could be entirely evacuated, thus removing the objectionable oxygen. Photographs which he obtained of the spectra of gases have never been duplicated in clearness. Schumann died something over a year ago.

We have considered briefly the nature, properties and methods of production of ultraviolet light. There is still one property which has barely been mentioned and is important as it leads to a practical application of the rays. This is its action on living bodies, and particularly on the simplest of organisms known as bacteria. You will recall that bacteria consist of single cells of microscopic size,—approximately 1/25,000 of an inch long; that they occur in three forms,—cocci or spheres, bacilli or rods, and spirilla or spirals; that they reproduce by simple cell division; and that for the most part they are not only harmless but quite necessary for present life. A few, however, are the cause of at least some of man's ailments. Typhoid fever is one of the diseases for which bacteria are responsible. Typhoid is an intestinal trouble and the organisms leave the patient in the discharges. If this material gets on any food or into milk or water and is swallowed by another person, typhoid may result.

In order to prevent the spread of this disease and of other intestinal troubles by means of drinking water, great care has to be taken. If the source of supply cannot be sufficiently controlled to insure safety to those using the water, it is necessary to resort to some artificial means of purification. One method is to pass water through beds of sand about four feet deep. A slimy mass collects on the surface of the sand and strains out the bacteria. This method, known as slow sand filtration, is in use for a large number of public supplies. The filters will deliver from $1\frac{1}{2}$ to 3 million gallons of water per acre each 24 hours. Another method is to add some chemical, such as alum, to the water to produce a flocculent precipitate which acts as a coagulant for the bacteria and other suspended matter. The precipitate is then removed by a layer of sand. This method is called "mechanical" or "rapid" filtration,—the rates of filtration being very high, from 100 to 150 million gallons per acre each 24 hours. Rapid filtration is of advantage particularly in handling highly colored or turbid waters. These filters are also made in sizes sufficiently small for use in manufacturing establishments, institutions, hotels, swimming pools, etc. For still smaller amounts of water there are a number of so-called filters on the market, some of which may work well when kept in proper order, but many of which are useless or worse.

Besides filtration, danger from disease may be removed by adding to the water some substance which will kill the harmful bacteria. Fortunately, typhoid bacilli are less resistant to disinfectants than many of the harmless organisms and so are among the first to be attacked. Now, caution must be exercised in the choice of a substance to be added to a drinking water, as it is obvious that poisonous material or anything giving a taste must be absolutely avoided. The most common chemicals in use for sterilizing water are compounds of chlorine,—sodium or calcium hypochlorites,—the latter going under the name of "chloride of lime" or "bleaching powder." Chlorine gas itself has recently been put into some use, as reasonably good methods of handling it have been developed. These substances are all good disinfectants, are not poisonous in the quantities

which it is necessary to use, and should not leave any disagreeable taste in the water. So far, bleaching powder has proved the cheapest and easiest for general use.

A more recent development has been in the application of ozone. Ozonized air is made to pass through and mix with the water and the ozone coming in contact with bacteria is supposed to kill them. This is not the place for a discussion of the merits of this system.

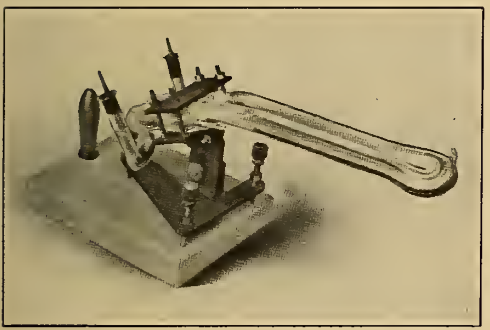

Figure 2

A still more recent method is the use of the ultraviolet rays about which we have been talking. It has been known for a long time that sunlight has an injurious effect on the growth of bacteria, yeasts and moulds. Indeed, this is a matter of common knowledge to the housekeeper. The rays which have the germicidal action are those at the violet end of the spectrum, and ultraviolet light is particularly active,—the shorter the ray the greater its activity. The light practically available is limited by the absorptive power of the material used in making the lamp.

There is certainly no doubt that large numbers of bacteria can be instantly killed if properly exposed to ultraviolet light. The action is probably purely photochemical, and does not take place through the intermediate formation of ozone or other disinfectant. Henri, a Frenchman who has made quite a comprehensive study of the subject, believes that the rays act on the walls of the bacterial cell to produce poisonous products which then diffuse into the protoplasm.

It is only about eight years since the first important work was done on the practical application of ultraviolet light for water sterilization, but some very important improvements have been made since that time. The first problem is the production of the rays. This is done by the use of the quartz-mercury-vapor lamp, and an electric current. Figure 2 represents one of these lamps, the black area being the mercury. In starting, the lamp is tipped so that the mercury makes contact with the two terminals and the current passes. This immediately volatilizes a little mercury. The lamp is then put back into place and the mercury vapor carries the current, giving a strong light, so strong that it is dangerous for the eyes, and can cause a violent sunburn on the skin.

The second problem is to get the rays in contact with the bacteria in the water. Clear colorless water will allow the light to penetrate about one foot, but if either color or suspended matter is present the distance is much reduced. It is therefore

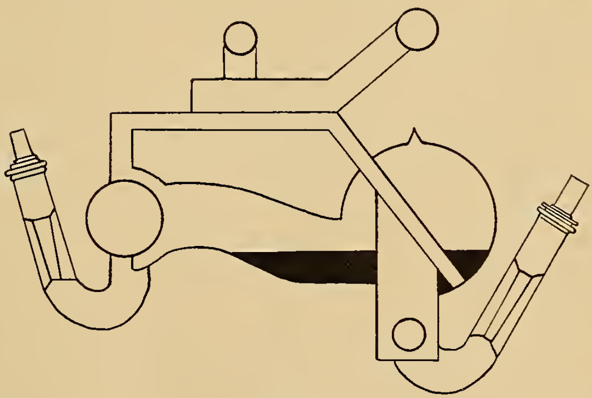

Figure 3

necessary to have the water exposed to the light in thin layers, as well as to have it as clear and colorless as is possible. On this account it is often wise to filter a

water before treating it with ultraviolet rays. The light would then act as a precautionary measure by sterilizing after the majority of the bacteria had been removed. This will render the water doubly safe.

There are a number of machines on the market for ultraviolet sterilization, the style depending on the amount of water to be treated,—whether it is to be used for a small family, a hotel or factory, a swimming pool, or a public supply. Figure 3 shows a so-called pistol lamp which is used particularly for large supplies.

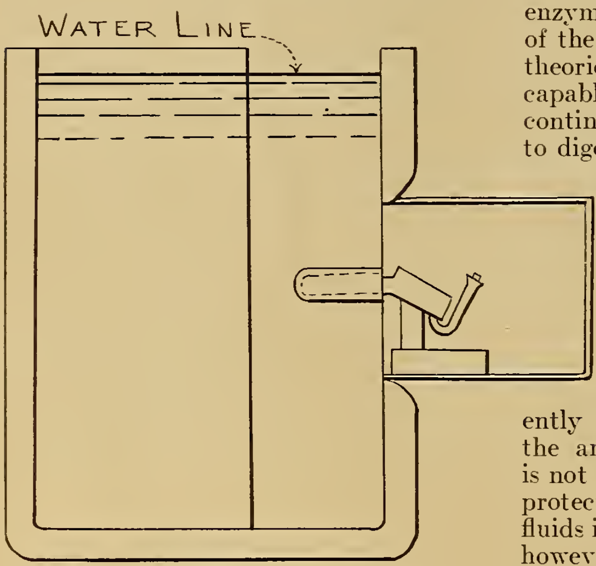

Figure 4

Figure 4 shows how this lamp is placed in a canal with a baffle plate in front of it so that all the water passing through must come in close proximity to the light. If a number of these are placed in succession in a canal, even the most hardy bacteria have small chance of coming through alive.

The only practical drawback to the use of ultraviolet light for water sterilization is that of expense. However, where cheap electricity is available, or where it is obvious that expending a little money will bring a large amount of safety, it is certain that the method ought to find an important field of service.

THE UNSOLVED MYSTERY OF WHY THE STOMACH DOES NOT DIGEST ITSELF

It has often been questioned why the stomach does not digest itself. Proteids in the shape of tissues of other animals rapidily dissolve when introduced into the gastric juice but the stomach tissue itself is never attacked by its own gastric juice. Among the various reasons that have been suggested are the protective influence of the mucous secreted along the digestive canal, and the existence of antienzymes, which counteract the activity of the digestive juices. Neither of these theories has, however, been accepted as capable of explaining the complete and continued immunity of the digestive tract to digestion. It cannot even be asserted that it is simply because these tissues are alive that they are thus protected since the living mucous membrane of the urinary bladder, for example, is dissolved by the pancreatic or gastric juice of an animal of the same species. Even the living mucous membrane of the intestine is apparently digested by the gastric juice of the animal to which it belongs if food is not introduced at the same time. The protection of living tissues to digestive fluids is thus limited. On the other hand, however, some aquatic forms of life, such as protozoöns, worms, crustaceans and insects have been kept alive at times for a month, in a solution of trypsin that would quickly have dissolved a mass of dead protein.

So a correspondent to the *Journal of the American Medical Association* for July 18, 1914, concludes that the continued immunity of the mucous membrane of the stomach to an active gastric secretion and of the intestinal mucous membrane to pancreatic juice still remains a mystery. Some unknown protective power of adaptation under certain circumstances must be admitted as one of the innumerable factors of evolution of which we are still ignorant.

H. W. S.

A NEW PUBLIC HEALTH WORK

THE VITAL NECESSITY OF MOUTH SANITATION TO SAFEGUARD AGAINST INDIVIDUAL AND COMMUNITY INFECTION AND RAISE THE GENERAL HEALTH LEVEL

BY WILLIAM R. WOODBURY

One wonders that it has taken so long a time to give to the most necessary and useful part of the human body the recognition due it. For only recently have the mouth and teeth begun to receive proper care and attention. Little thought has been given to safeguarding the gateway to the body—the only entrance through which nourishment comes, and the ready, open and exposed entrance and seat of infection which makes disease.

There is hardly a body ailment which does not find entrance through neglect of this gateway. Even the lungs are made to suffer through the common habit of mouth-breathing—an unnecessary and harmful practice which lets into the breathing organs air not properly warmed and cleaned.

The burden borne by the neglect of the mouth falls heavily, soon or late, upon nearly every member of the community. No family investment saves or earns more in health and capital than the money spent for prompt and thorough care of the mouth and teeth. One thorough mouth cleaning for one boy or girl with several teeth in an offensive and insanitary condition costs more than the preventive care of all the teeth of an entire family for ten years.

So common have decayed and diseased teeth and crippled mouths become that this condition is recognized as The People's Disease. It is rare to find a man, woman, or child who has not become its victim.

We have all been told more than once of the daily care needed to keep the mouth clean; and that it is a means of protection against disease and expense which the individual can control, and for which he alone is responsible. But how many of us take five minutes every morning and every night out of the crowded hours of our daily life to practice this care?

There is a wide discrepancy between knowledge and application; and in this means of conserving health a great public need awaits being met. Good earning capacity demands a sound body and strong health. Poor condition costs money; it blocks growth and development; it whittles away the uncertain health which always goes with poor physical condition; it invites sickness and disease; it spoils usefulness and enjoyment. It is a constant menace to others; and it imposes a burdensome tax upon the community. It adds to the cost of living.

We live in an age of sanitary conscientiousness, and in fact, as well as from the point of common decency, no one has a right to subject his neighbor to the danger of infection, any more than he may do him physical violence.

These facts make the care of the mouth a matter which is of vital concern to community health. Through carelessness and neglect on the part of the individual it has become a part of public health work to spread widely knowledge which will help prevent and control The People's Disease. This growing work keeps before the public constantly the opportunity to learn and to practice the control of one of the most common causes of sickness and economic waste; and to help advance towards solving the complex problem of the prevention of disease.

Closest attention must be given to the prompt care of children's teeth. From the small and seemingly insignificant beginnings of early tooth-rot—conditions which too often escape early discovery and attention—much of the sickness in

childhood comes. In the prevention of sickness it is just as important to control the minor ailments as the major ones. The smaller ones hit us so much oftener. Active and continuous minor attacks of illness finally open up the breach through which general disease enters, and demolishes the body's resistance.

Malnutrition, with its many damaging results, begins with the incomplete chewing of food. The first muscles which the new-born baby uses are the chewing muscles. When the baby nurses these muscles work vigorously; and the increased flow of blood maintained by their use brings to every part of the head and to the brain the full supply of blood needed for their normal and progressive growth and development. Long before the baby can use its arms or legs, or even hold up its head, the chewing muscles are well-developed and doing active work. The constant use of the chewing muscles helps develop a well-formed and symmetrical face and head. These muscles assist in developing and strengthening the teeth; and when the teeth come, and with them the demand for solid foods, the child is ready to manage and use those foods completely.

The chewing and the grinding strength of the jaws and mouth is a nicely adjusted mechanical force. In the full-grown adult a crushing and grinding strength of 250 pounds is demanded to carry on properly the first stage of the process of orderly digestion. Well-fitted artificial teeth—the best that the most skillful mechanician can make—are a poor substitute. Their biting strength is but 25 pounds; and as grinders they are inefficient tools.

The teeth are the hardest organs in the human body, and the most durable when given reasonable care. In their structure and material they are harder than the bone substance and structure. Every one of the permanent teeth is built to last through all the years of life. There is not one tooth too many; and the work of them all is demanded all the time.

Never should a child be sent to school whose mouth and teeth cause poor condition or disgust. Such a defective child becomes a public charge which increases the tax upon the community purse to carry it through its school years, to develop not infrequently into a defective and inefficient man or woman. Most of the problems of school hygiene are those imposed upon the community by the poor physical condition which the child brings when it begins its school work.

Another burden which taxes the community is that children with neglected and crippled mouths are ready victims of the infectious diseases—diphtheria, scarlet fever, and measles. They invite these diseases; and their foul, neglected mouths are breeding places and carriers of the active agents of infection. They are a constant menace to the health of all their schoolmates, and wherever they go. Children play very close together, and they have a habit of putting everything in the mouth.

Mouth conditions are of the greatest practical importance in tuberculosis. In the prevention and control of tuberculosis the largest and surest benefits come from good sanitary conditions; and mouth sanitation is of vital significance. A neglected mouth and decayed hollow teeth are important factors in spreading this disease.

Nearly every kind of bacteria at some time finds entrance and takes refuge in the human mouth. Pneumococci, the infection which causes pneumonia, can be found quite generally in the mouth. Though always a menace, but not dangerously aggressive until, through a greatly reduced vitality and depleted physical condition, an ineffective resistance is reached, the danger is ever present in a neglected mouth.

In his account of a visit to the American Ambulance Corps in Paris, Peter McQueen describes two or three remarkable things which he saw and heard: "In the first place, the Americans begin their work of healing by having the free services of the best American dentists in France two whole days a week. Every patient has his teeth looked after. They found that the English have the worst teeth and the Arabs have the best. They found many men suffered more from their

teeth than from their wounds. Inflamed gums were very common among the French and English. The Moroccans and Algerians have almost perfect teeth. By attending to the teeth, the American doctors cure the wounded ten days faster than any other corps now working either with the Germans or the Allies."

Of all our diseases cancer, to-day, has the largest mortality from among those who have reached adulthood. Of those who have attained the age of forty, one in eleven dies, and death comes at the time when the individual is in the height of usefulness and activity in the home and community. Death from cancer seems to be increasing. The chief facts known about this disease are that it begins as a definitely localized disease in some point of irritation, and, if neglected, spreads to other parts of the body. Irritation due to a diseased, sharp tooth, and persistent indigestion provoke cancer. A crippled mouth and diseased teeth, and careless incomplete chewing are highly important factors in maintaining persistent indigestion.

Here, again, public education in the prompt care of the mouth and teeth needs to be urged. It is an undeniable factor in helping prevent the worst remaining disease.

Ninety-five out of every one hundred adults have receding gums—Rigg's Disease; and too often the unhealthy condition is permitted to develop into active sources of infection which poison the whole body. The abscesses which may develop about the teeth-sockets in the gums lead to the loosening and loss of the teeth one by one. When this condition has fully developed, attempts to save the teeth are ineffectual—it is too late.

The absorption of infection from around diseased teeth mav so damage the heart as to cause leaky valves. Rheumatism can develop from the oftentimes unsuspected abscesses concealed in the mouth.

Man has twenty teeth with which to grind his food. If he does not do the necessary grinding throughout his entire life, and swallows his food in chunks, washing it down into his stomach with liquids, he invites sickness, disease, and premature death.

A whole clean mouth helps make a healthy body; it helps make and keep useful health; it prevents infection and disease from disorganizing the functions and work of every organ in the human body; and it prolongs life. A neglected mouth and poor nutrition makes defective, inefficient, and diseased children, women, and men.

From every quarter, near and remote, comes a plain call for active public health work everywhere for prompt and constant care of the mouth. Individual and community efficiency and economy demand checking the present and generally wasteful expenditure of health and human life; and of eliminating, so far as is possible, every factor which works for crippled health, quickly spent lives, and needless sacrifices and suffering. Such work is well worth while.

With this work wisely planned and with its foundations well laid there needs to be fullest scope and broad and natural ways for increasing its certain benefits. Facts seen on every hand—and in so many mouths—facts which so many of us know from our own personal experiences, point the necessity for this work. The lessons told by neglect of the gateway of the human body stand out clearer to-day than even only a few years back. More and more they are beginning to take firmer hold upon us. To attempt to get through life without taking just account of these facts and lessons hastens physical disaster and untimely dislocation of the affairs of life. Both the fixed and quick capital which every man and every woman needs are consumed much too quickly and wasted. It is good business —it is practical, wise economy to reduce to the minimum the outlay in money and time for repairs and upkeep of every part of the body.

Nutrition—the first factor in maintaining life—comes from the food which enters the body. The fullest benefit and a large part of the enjoyment from our food comes from chewing. When the work of the mouth can not be done properly an added and overburdening

weight of work is piled upon all the other organs—work which none of them can do. When the gateway is kept whole and clean, and every part of the mouth and all the teeth do their full work, nutrition begins right; a damaging tax does not fall anywhere.

Safeguarding the mouth and giving this body gateway early, prompt, and constant preventive protection is worthy of our best efforts; the work is far-reaching. Broadly speaking, and by the letter, too, every undertaking which works towards the benefit and upbuilding of the human body of this generation and of the next and following generations of men and women holds an important place in public health work.

Nowhere is there an institution which is doing more and better work, and out of which more thorough and more far-reaching good can grow in so many directions, than is being done by the new Forsythe Dental Infirmary for Children, of Boston. The first institution of its particular kind for promoting public health, it stands out as the pioneer in a new field of health work—a field in which much patient work is waiting to be done.

Dedicated and devoted wholly to children under sixteen years of age, it offers to thousands of the rising generation of men and women opportunities which their parents cannot buy for them. It gives them the opportunity they need for the timely repair of defects and beginning damage. This noble institution, and those of its kind which are to come, enables *children* to establish and maintain the upkeep of sound body health; helps them learn to practice that care which diminishes sickness; saves their health, time, and money; adds to their capacity for living; and prolongs useful lives.

SOFTENING RUST

A recent issue of the *Brass World* contained a simple method for removing rust. It consists in dipping the articles first into a strong hot potash bath for about half an hour, and then immersing in a cold muriatic acid pickling solution, composed of two parts of water to one of acid. This removed the rust in a few minutes, leaving the metal apparently attacked but very little. The previous soaking in the strong hot potash solution is responsible for this rapid pickling, as a test proved, for without the previous dipping, sixty-five minutes was required by the acid bath, against four minutes when previously treated in the potash bath. Apparently a chemical reaction is set up, changing the character of the rust, softening it and making it readily soluble. The pieces that have been treated in the potash bath have a smooth and glossy finish.

SCIENCE CONSPECTUS

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PRESENT STATUS OF SUBMARINE BOATS

A DISCUSSION OF THE PRINCIPAL FEATURES OF UNDER-WATER WAR CRAFT, THEIR ARMAMENT, MANEUVERING, LIMITATIONS AND MILITARY VALUE

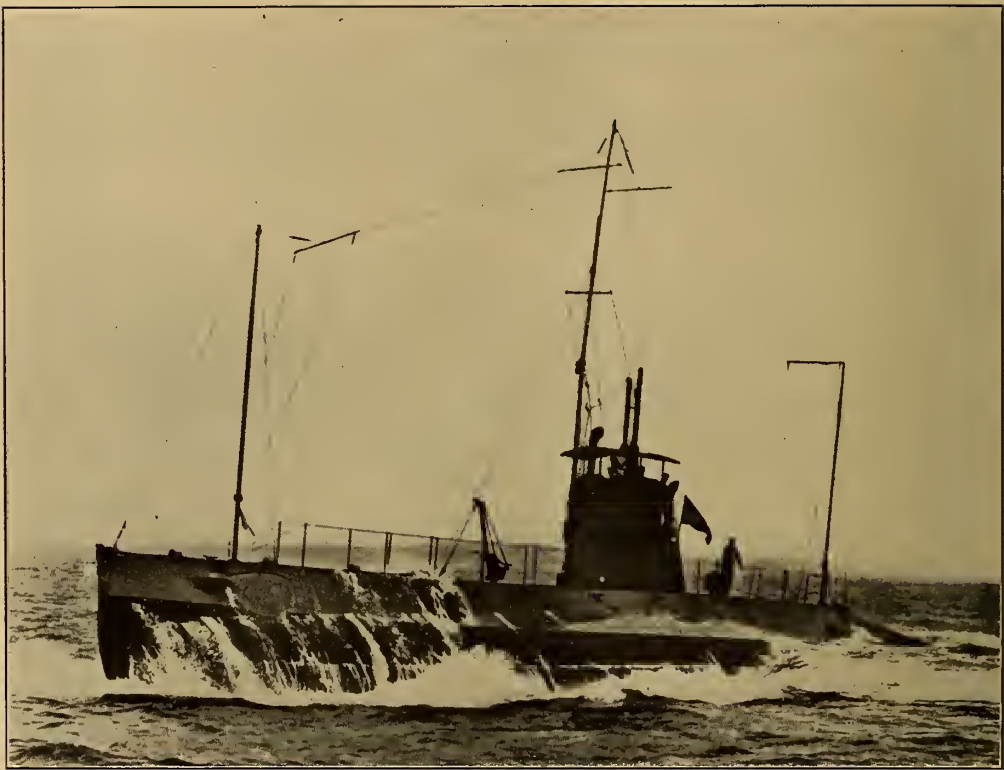
BY WILLIAM HOVGAARD

SUBMARINE boats occur in two varieties, "Submersibles" and "Submarines." Although the line between the two types is not always easy to draw, each of them in its pure form possesses certain characteristic features which it is of importance to understand.

SUBMERSIBLES AND SUBMARINES

A "submersible" may be defined as a submarine boat in which predominant importance is given to the requirements of service in the surface condition, while a "submarine" is designed more particularly with regard to the submerged condition. Hence the submersible is given a ship-shaped external form, while the submarine is more nearly cigar- or spindle-shaped with circular sections. The ship-shaped form of the submersible is, however, attained without abandoning the advantage of the circular section which is maintained throughout an inner spindle-shaped "strength-hull," being the form best adapted to resist the pressures of the water. Between the inner and the outer shell are water-ballast tanks and oil tanks, whence the strength-hull may be of small diameter well suited to resist great pressures without going to excessive scantlings. The outer hull, not being exposed to great pressures, may be lightly built, but will yet in some measure protect the inner hull against damage by collision. The ballast and oil tanks may, with a relatively small addition in hull weight, be made very large, whence a great reserve buoyancy and great radius of action can be secured. In a submarine the tanks are chiefly inside the strength-hull and cannot, therefore, be very large without unduly increasing the diameter of the hull and hence its tendency to collapse.

Speaking broadly the submersible has better seagoing qualities, and higher speed on the surface than the submarine, but the form is not so favorable for driving under water. Most early boats were submarines. It was natural that inventors, especially those not acquainted with the requirements of naval service, should direct their efforts especially to navigation under water and that they should underestimate the importance of qualities required for work on the surface. At present the general trend of the development is toward the submersible type. Of recent years, therefore, the submarine, where it is still retained, has been made to approach the submersible more and more by enlarging the superstructure and giving it a more ship-shaped form. In English subma-

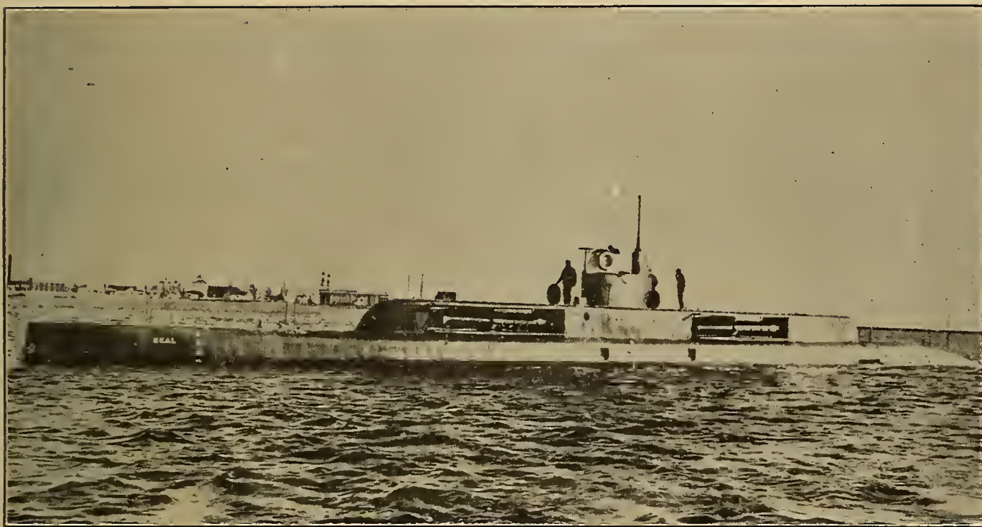


U. S. Submarine *K1*, Holland type (Electric Boat Company)

rines side structures have been added. The reserve buoyancy in the early submarines was only about 5 per cent. of the light displacement but has been gradually increased to about 18 or 20 per cent. In submersibles, on the other hand, the reserve buoyancy has been reduced from about 72 per cent. in the first boat of this type, the French *Narval*, to about 35 per cent. or less in recent boats.

The submersible, as, for instance, the *Germania* type, has a relatively high center of gravity and hence small stiffness in submerged condition on account of the high position of the tank structures, while in the surface condition the stiffness is in some cases excessively great due to the large area of the waterline. The submarine, exemplified by the *Holland* boats, has a low center of gravity on account of the low-lying water tanks and therefore great stiffness in the submerged condition but small or moderate stiffness on the surface. The *Laurenti* type, where the ballast tanks are partly below the strength-hull, partly above or, at least, very high, are intermediate between the *Germania* and the *Holland* type in this respect.

In order to obtain sufficient stability in the submerged condition submersibles must generally carry a considerable amount of keel-ballast. This of course is a drawback, but also most submarines carry some ballast. Part of the ballast is generally detachable, often referred to as a "safety keel," to be let go in case of emergency. In passing from the light to the submerged condition and *vice versa* a point will exist where the stability is a minimun, being reduced by the presence of free water in the tanks. The designer must, therefore, carefully determine the conditions of stability in all intermediate positions in order to satisfy



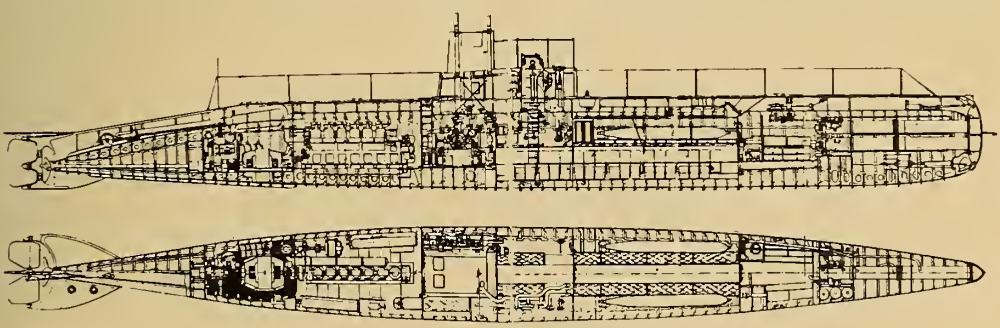
U. S. Submersible *Seal,* Lake type

himself that a proper metacentric height is always maintained. If the stability vanishes at any point the boat may heel over to a considerable angle before equilibrium is restored or may even capsize.

STRENGTH AND CONSTRUCTION OF HULL

The hull of a submerged vessel is exposed to an external water pressure which is directly proportional to the depth of immersion. Already at a depth of 200 feet the pressure is about 100 pounds per square inch, and since the depth of water in the ocean is generally more than 10,000 feet, boats cannot be constructed to withstand the pressures at all depths which they may encounter. It is therefore necessary to assign a limit to the head which a boat is required to resist. Generally there will be no object in going deeper than required to clear the bottom of vessels on the surface, that is, to a depth of about 75 feet, but accidentally boats may descend involuntarily to greater depths. Usually the head to which boats are tested is about 150 feet, in the United States Navy it is 200 feet. A certain margin of safety is, of course, applied in the construction, but if a boat goes much beyond its test depth it is liable to collapse. In most boats the strength-hull is made of circular section as stated above.

The Whitehead boats and other boats



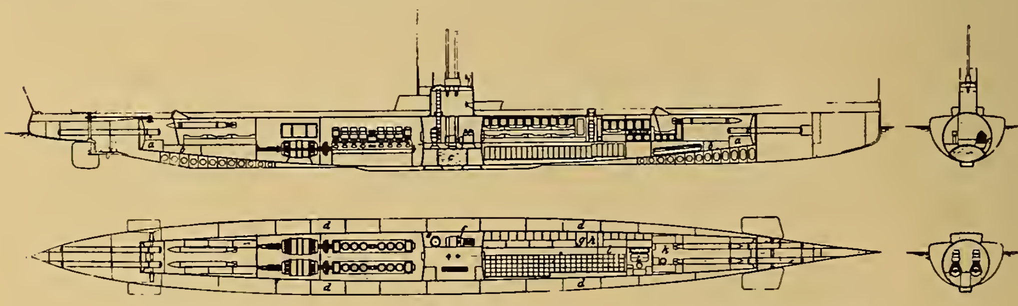
Danish Submarine *Havmanden,* Holland type (Whitehead)

Greek Submersible *Delphin,* Laubeuf type

of the *Holland* type have internal frames. As seen from the midship section of the Danish submarine *Havmanden*, the Whitehead boats in some cases have oval sections even amidships, because this form is convenient for operating in shallow water. Some boats, such as those of the *Germania* type have no frames. Boats of the *Laurenti* type appear to use the frame-work between the inner and outer hull as a means of stiffening the strength hull.

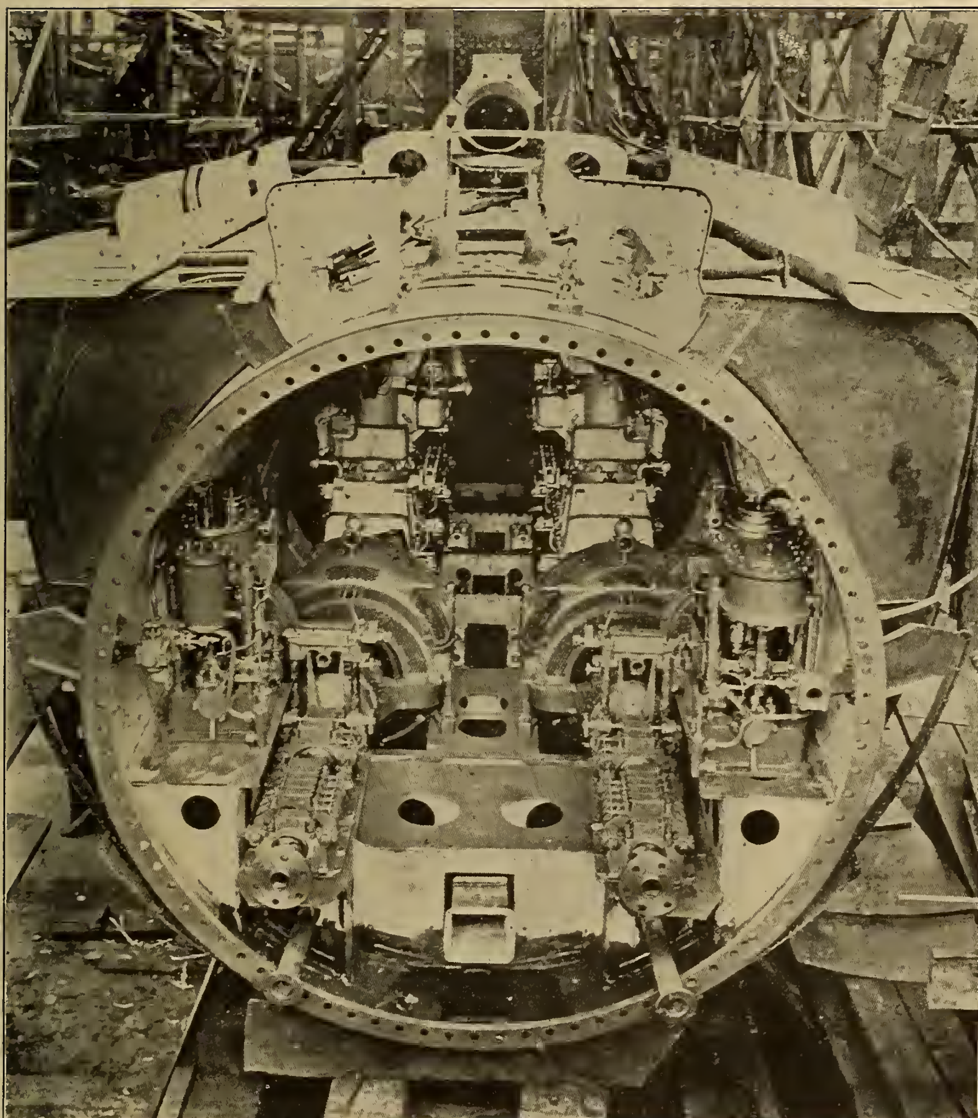
STEERING AND NAVIGATION

Steering in a horizontal direction takes place as in ordinary vessels, but steering in the vertical plane has caused many difficulties to early inventors. As late as 1901 a German authority, Professor Busley, deprecated the value of submarine boats on that ground. Mr. Holland introduced diving and emerging by inclining the boat at considerable angles, while most other inventors preferred to keep the boat as nearly as possible on an even keel and to effect great changes in depth either by pumping water in or out of the boat, or by means of horizontal propellers, or by so-called "hydroplanes." The last method appears to be that which is mostly used in submersibles. Hydroplanes are similar to rudders, sometimes fitted amidships abreast of the center of gravity of the boat, sometimes placed forward and turned the same way as the aft rudders. In all cases the object is to produce an upwards or downwards force driving the boat up or down parallel with itself. This method is generally considered safer than the "porpoising" used in the *Holland* boats. Once the desired depth is attained, it is preserved by means of the horizontal rudder in the same way as when steering a course on the surface, but with this difference that even small deviations from the given course line (depth) are not here permissible. For guidance in steering a depth gauge and a clinometer are used. Steering in the vertical plane requires considerable skill and experience.



a Trimming Tank
b Torpedo Tank
c Water Ballast
d Oil
e Main Ballast Pump
f Air Compressor
g Cupboard
h Water Closet
i Commanding Officer
k Officers
l Petty Officers

Submersible of Germania type

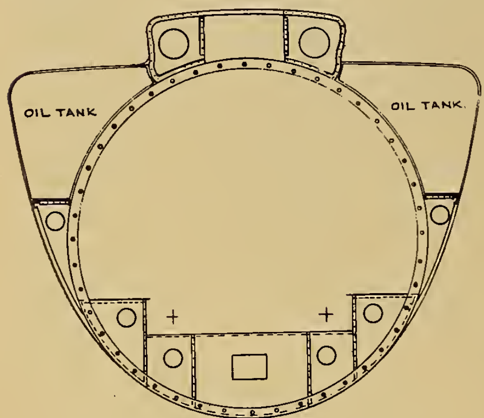


Internal View of Submersible *Kobben,* Germania type

In order to navigate, the submarine boat must be provided with a reliable compass and, even when submerged, a view of the horizon must be obtainable at any time. An ordinary magnetic compass is not quite reliable even when placed in a conning-tower of bronze, but recently the advent of the gyro-compass has provided a means of accurately determining the direction independent of magnetism. The faculty of vision when the boat is submerged, as it must be when making an attack, constitutes one of the most important and difficult problems connected with submarine boats. The water is practically opaque and it was therefore necessary in early boats, when going under water, to emerge

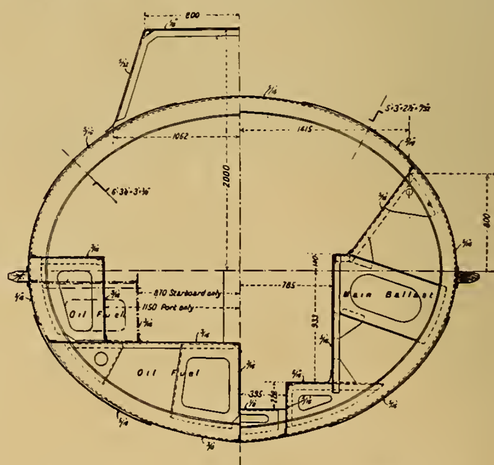
Italian Submersible *Foca*, Laurenti type

from time to time so as to obtain a view from the conning-tower, but evidently this mode of navigation was anything



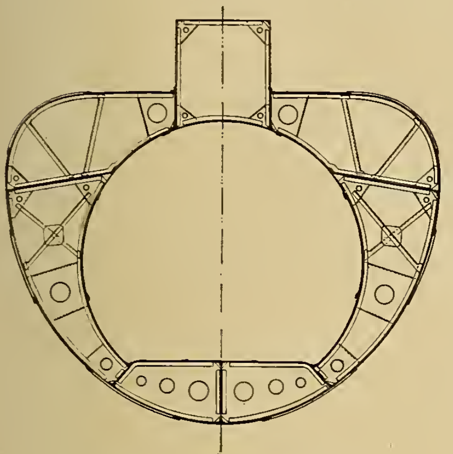
Midship Section, Germania type

but safe since the presence of the boat was thus revealed to the enemy. Already in the eighties and nineties optical tubes were introduced of simple construction, invented by Marié Davy in 1854 and gradually perfected. In its simplest form the optical tube had a mirror at each end inclined at 45° to the axis. The tube, being fitted watertight in the top of the boat, projected a few feet above water when the boat was immersed and thus a view of the horizon might be obtained, but the arc of vision was at first only one or two degrees, and the image was very imperfect. The mirrors were replaced by prisms, lenses were introduced, and during the nineties several improvements were made, but not till about ten years ago was any serious progress made. Then, in a few years the optical tube or "periscope," as it is now usually called, was developed to a high degree of perfection, enabling the submarine boat to perform attacks without showing anything but the top of the periscope occasionally above water, at the same time obtaining a perfect view of the enemy. The improvements comprise a larger field of vision spanning an arc of more than 50°, as large or greater than that of the human eye, convenience of observation, and the addition of means for measuring distances and indicating directions. The magnification of the



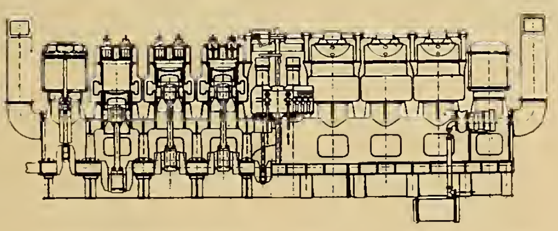
Midship Section of *Havmanden*, Holland type

object is only about 1.5, which is found to give to the observer the same impression as when using the naked eye. By using the utmost refinements of optical art and science a perfect image of un-



Midship Section, Laurenti type

surpassed clearness and distinction is obtained. Mechanical power is employed for handling the tube, enabling it to be pushed up and down readily and quickly and to be turned round its axis. The length of modern tubes is up to 25 feet with a diameter of about 6 inches. The head of the tube projects from 10 to 20 feet above the hull. Difficulties still exist due to the vibration of the periscopes and spray on the front glass, but they are of secondary importance. Instruments have been constructed by which an all-round view of the horizon can be obtained without turning the tube, but have not proved quite satisfactory. The perfection of the periscope was the last link in the chain of inventions and improvements that were needed to endow the submarine boat with positive military value.

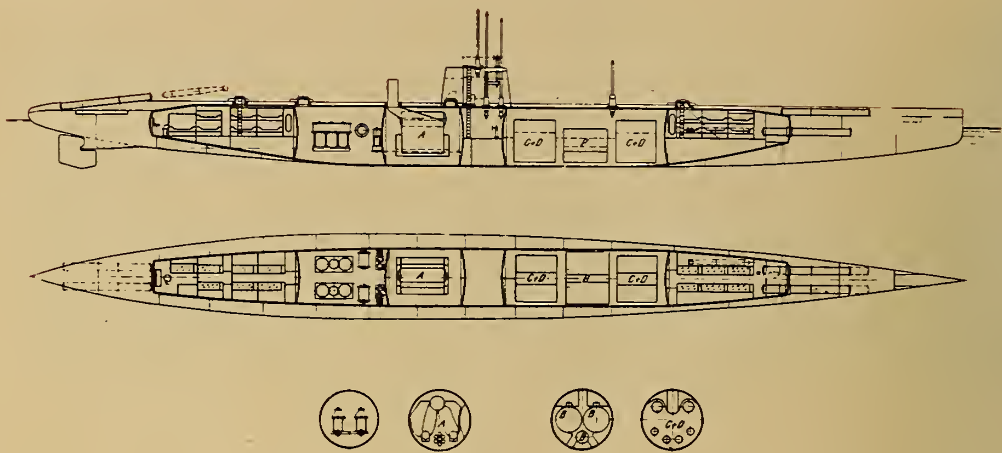


Diesel Engine, Germania type, 900 H. P., 450 rev. per min.

VARIATIONS IN BUOYANCY

In order to go from the light to the submerged condition and *vice versa* it is necessary to admit or to discharge water. Main tanks of great capacity must therefore be fitted, provided with large sea-valves and powerful pumps. The water may if desired be forced out of the tanks by compressed air. The time occupied in passing from the surface to the submerged condition should not be more than about from four to five minutes. This, of course, is a point of great military importance. When a boat is completely submerged the main tanks are always entirely filled, and its weight is generally so adjusted that it falls a little below the buoyancy, leaving a tendency for the boat to rise to the surface. This tendency is overcome dynamically when the boat is in motion either by a slight inclination of the axis or by hydroplanes. The fine adjustment of the buoyancy takes place by means of a central auxiliary tank of moderate capacity used to compensate for incidental disturbing causes, such as variation in the specific gravity of the sea-water or consumption of stores. Smaller tanks near the ends of the boat permit an adjustment of the trim. Special tanks are fitted for compensating for such definite changes in weight as when a torpedo is fired and another inserted in the tube. In some boats a so-called "floating-tank" is fitted, which serves to compensate automatically for incidental variations in buoyancy occurring while the boat is under way; it is connected with a continuously acting pump which is worked in conjunction with the horizontal rudders. A considerable amount of buoyancy can be obtained almost instantaneously by the release of a safety-keel consisting of detachable blocks of lead ballast which are let go in case of emergency.

The superstructure which is above water in the light condition is self-bailing. In some boats it is built entirely and permanently open, serving



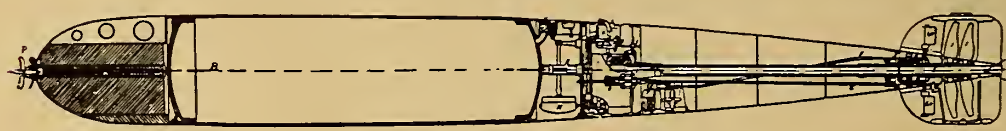
Boat with Soda-Boiler, d'Equevilley type

only to provide a raised platform, but in most boats it is a watertight structure provided with large and numerous valves that can be readily closed when the boat is in light condition whereupon the superstructure will add to the reserve buoyancy and the stability.

Section of Periscope

VENTILATION AND HABITABILITY

Space is always restricted in a submarine boat. When going on the surface the motor gives off much heat and requires a great amount of air for its combustion. It is unavoidable that some of the products of combustion, carbon monoxide and carbonic acid, leak out from the engine. Also the men consume oxygen and produce carbonic acid, and when charging the batteries free hydrogen is liable to be liberated, forming with the air in the boat an explosive mixture and carrying with it particles of sulphuric acid. Where the fuel is gasoline or other volatile oil, it will evaporate at a low temperature and is liable to leak out into the boat; it is poisonous and capable of forming an explosive mixture with the air. For these reasons, it is necessary to provide a very vigorous ventilation when going on the surface. In the submerged condition, the problem would appear to be even more difficult because the available air is gradually vitiated, but it is found that with proper precautions the crew can live for twelve hours or more without any sort of air renewal or means of purification. This is due to the constant leakage which takes place from the compressed air system, a leakage which can never be entirely prevented. If desired, the carbonic acid which gradually accumulates due to exhalation may be removed



Longitudinal Section of 18-inch *Mark II.* 5 Metre Whitehead Torpedo
Speed, 30 knots at 1,000 yards, 24 knots at 1,500 yards

Explosion of a Mine

by chemical means or the foul air may be pumped out. Fresh air can be supplied as desired from the compressed air reservoirs or pure oxygen may be added. There is, however, rarely occasion for resorting to such means except in case of serious accident. A greater difficulty is the escape of gasoline and poisonous fumes from the motor as well as from the battery. There is no convenient test for carbon monoxide suitable for use in submarine boats, whence it has been necessary to use white mice for indicating the presence of this poisonous gas to the effects of which these little animals are very sensitive. White mice breathe much more vigorously than human beings and will absorb carbon monoxide about twenty times as rapidly as man. Hence, long before man feels any discomfort, the mice will show symptoms of distress. When this occurs and, especially when the mice become asphyxiated, it is necessary to ascend to the surface and to renew the air in the boat.

Life on board a submarine boat is very fatiguing and for this reason the time in which a boat can stay away from its base is very limited. The crew has to be

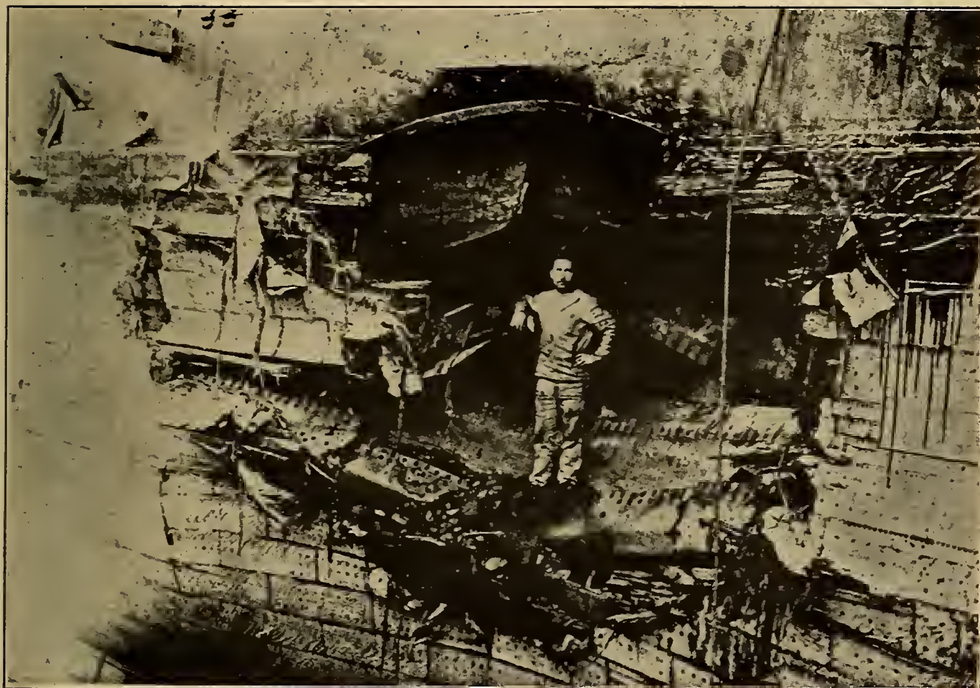
changed at frequent intervals or it must be given time to recuperate, a fact which in many cases may limit the practical endurance of the submarine boat more than the supply of fuel. Under war conditions the crew of a submarine boat ought probably to be relieved after a few weeks' service, depending of course on the size and design of the boat and on the climatic and military conditions.

PROPULSIVE MACHINERY

For propulsion on the surface the gasoline motor was the first really successful engine. It was light, occupied small space as compared with the steam machinery and the combustion of fuel oil was not more than about one-half pound per H. P. hour as against at least 1½ pound per H. P. hour for steam machinery. For small boats, of a displacement of from 100 to 300 tons, where weight and space were very restricted, the gasoline engine offered the best solution, but the dangers from this volatile oil soon made it necessary to introduce heavy-oil motors, although they were in several respects inferior to the gasoline motors. While the latter are easy to start, special means are required for starting the former, and the consumption of fuel in heavy-oil motors such as those of the Koerting type was about twice as great as in the gasoline motors. The last step in the development was the introduction of the Diesel engine which likewise burns heavy oil. Although in itself rather heavy, it has a consumption of fuel somewhat less than that of the gasoline engine, and this is its principal advantage. The nominal radius of action of recent boats of the largest size, driven by Diesel motors, is given as about 3,000 miles. The speed on the surface has attained 16 knots in several boats and the designed speed in some boats now under construction is 18 or 20 knots.

The Diesel engine, then, is the motor which today finds most favor in submarine boats, but with the increasing size of boats and the claims to higher speed it becomes increasingly difficult to produce motors of this type of sufficient power. Units of from 1,300 to 1,500 H.P. with a power per cylinder up to about 200 H.P. are under construction and there are usually two and in some boats three propellers. Many difficulties are met with and failures have occurred, whence steam power has been preferred in some boats as for instance in the French submersibles *Gustave Zédé* and *Nereïde* of 1,000 tons displacement, which are to make 20 knots. Steam machinery has the advantages of reliability and durability, but it occupies more space and it is difficult to get rid of the heat. The radius of action obtainable with steam power on a given supply of fuel is much smaller than with Diesel motors. The weight of Diesel engines as fitted in submarine boats is about 65 pounds per H.P. as compared with about 50 pounds per H. P. for gasoline engines and from 50 to 60 pounds per I.H.P. for steam machinery inclusive of auxiliaries, propellers, and shafts. The Diesel engine is being steadily improved and will no doubt be successfully adapted for larger powers in the submarine vessels of the future, but as the size and power increase, the relative advantages of steam machinery will become more pronounced.

For underwater propulsion, electric power derived from a storage battery of lead accumulators still offers the best solution. Since the first appearance of these cells they have been improved upon in many technical details, and are now reliable and durable. They will stand complete charging and discharging more than 400 times and may be expected to last about five or six years under ordinary service conditions in peace time, provided they are carefully handled. The weight per H.P.-hour including outfit is by discharge in 3½ hours about 80 pounds, practically the same as in the early accumulators. Lead cells permit great variations in power and are at their best at low rates of discharge, a most valuable quality for submerged work. They can be stowed low in the boat and add thus considerably to the stability. They occupy about .4 cubic feet per H.P.-hour, *i. e.*, less than any



Damage to Russian Cruiser *Pallada* by Torpedo Explosion

other source of energy at present available for this purpose.

Attempts have been made to introduce accumulators of different type, the most promising of which are the Edison alcalic iron-nickel cells which have now come into serious competition with the lead cells and are to be tested in practical service on board some of the United States submarine boats. Before the result of this experiment is known, it is difficult to judge of the relative merits of the two types. It seems certain, however, that the Edison cells are more durable but more costly than the lead cells.

The total accumulated energy by storage batteries is necessarily small and rarely allows more than a speed of about 10 knots for 3 or 4 hours. Recently boats have been designed for 11 or 12 knots. The radius of action at maximum speed of large boats is about 30 or 40 miles, but at reduced speed a radius of about 100 miles is claimed for some boats.

The electro-motors including switchboards and leads weigh about 80 pounds per H.P. The excessive weight of the plant for underwater propulsion is the more unfortunate, since the weight available for propulsion is already very small as compared with that in ordinary torpedo-boats. The reason for this is that the hull weight is relatively great, occupying about 10 per cent. more of the total displacement than in a torpedo-boat. Only about 40 per cent. of the displacement of a submarine boat can be devoted to machinery and fuel as against about 50 per cent. in a torpedo-boat. Moreover, the plant for underwater propulsion comes as an extra addition and is practically a dead weight when the boat is going on the surface. It is evident, therefore, that submarine boats can never compete with ordinary torpedo-boats in point of speed.

Great efforts are being made to devise a type of machinery that can be used both

on the surface and submerged and especially one by which the propulsion under water does not entail any extra weight, but no satisfactory solution has yet been obtained. Any process based on combustion involves the storage of atmospheric air or oxygen, but a storage of these gases in sufficient quantities for underwater propulsion requires excessive weight and space. The discharge of the products of combustion is liable to reveal the presence of the boat.

M. d'Equevilley has proposed a solution which is being tried in the French submersible *Charles Brun* and probably also in a German boat. He uses an ordinary boiler with oil fuel and a steam engine on the surface, but when the boat dives under water the exhaust steam is led to a concentrated lye of sodic hydrate which absorbs the steam under strong evolution of heat and thus serves as fuel in a secondary "soda boiler." This process goes on till the lye is saturated. When the boat comes to the surface and steam is available from the primary boiler, the soda lye may again be concentrated by evaporation of the water which it has absorbed, and the boat is ready for another submerged run. This plan offers the advantages that there is no change of propelling motor, the same engine being used under water as on the surface, and there are no products of combustion. The machinery can be forced without difficulty and relative y high power attained both in light and submerged condition. No electric motor is needed. On the other hand, the system requires the addition of special soda-boilers and a hot water reservoir; the plant occupies so much space that the available weight cannot be fully utilized; the center of gravity of the machinery is high and requires extra ballast to be carried; the radius of action on the surface is necessarily smaller than with an explosion motor; there is likely to be a strong corrosion of the boiler due to the soda, and isolation for heat will probably cause difficulties. The soda-boiler installation appears, nevertheless, more promising than other power plants so far proposed for this purpose.

ARMAMENT

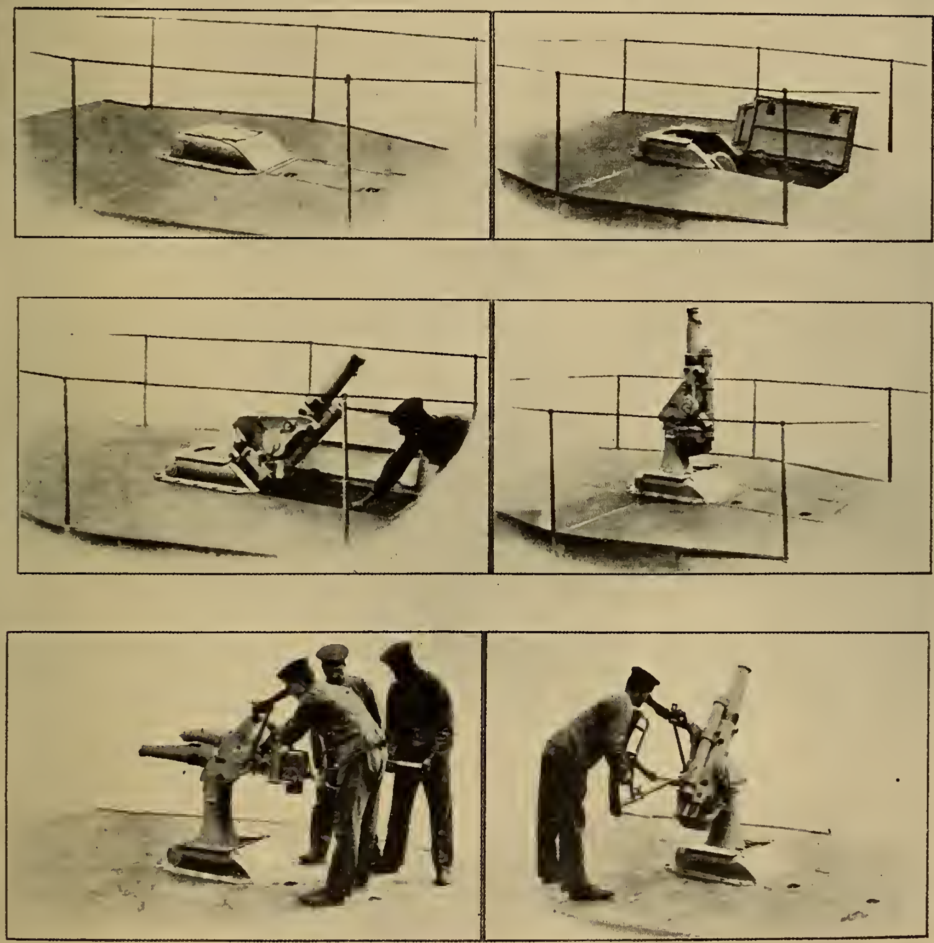
The principal armament of submarine boats is the Whitehead torpedo. Recent English boats are said to carry six 21-inch tubes and French boats of the latest type eight tubes. Modern large boats are equipped with an armament of light guns in disappearing mountings. English boats carry two 3-inch or 4-inch guns so mounted that they can be used against air-craft as well as against other vessels. When not in use the guns and mounts are housed in the superstructure.

Attempts have been made to design mine-laying submarine boats, a problem which is evidently of considerable interest. As far as known, Russia was the only power that, prior to the war, had built a boat for this purpose, viz., the *Krab*, designed for dropping mines when in surface condition. It appears that the Germans are now following the example of Russia. A boat so designed that mines could be dropped when in the submerged condition would be of greater value, but there are technical difficulties in releasing mines under water, in compensating for their weight and in determining their exact location. These difficulties have apparently not yet been overcome.

SIGNALLING

The faculty of communicating with other vessels whether on the surface or submerged is one of great military importance for the submarine boat. For service on the surface wireless telegraphy has been successfully used for several years, but for submerged service it is only quite recently that means of signalling have been devised which promise good results. It was at first, when the submarine bell was invented, attempted to use it for signalling, but it was found that it was not well adapted for sending messages by the Morse system. No practicable solution was discovered till an Austro-Hungarian physicist, Mr. H. C. Berger, showed the way by his experiments undertaken in the Danube at Buda-

DISAPPEARING GUN FOR SUBMARINE-BOATS.
CONSTRUCTED BY MESSRS. FRIED. KRUPP A.G., ESSEN (RUHR).



pest on the transmission of vibrations through water. A wire of two inches in diameter was set into longitudinal vibrations by the friction of a hand-driven silk-wheel moistened with alcohol whereby a clear and sustained note was produced, capable of being sent in dots and dashes of the Morse code. The wire was fastened to a plate in contact with the water, and was anchored at the other end to some fixture. The tension of the wire was immaterial. The identical apparatus used by Berger was fitted in one of the United States submarine boats in 1911 and readable signals were transmitted over a range of two miles. Still better results were obtained with steel ribbons and power driven exciters, by means of which distinct signals were transmitted over a distance of ten miles. Recently electrically worked oscillators developed by Professor R. A. Fessenden, have been used instead of the wire ribbons and have given very promising results. This mode of signalling is referred to as the "submarine wireless system," but it must be

distinctly understood that the transmission through the water takes place entirely by sound waves emanating from a diaphragm plate which may form part of the ship's side. The receiver is a similar plate in another ship similarly connected. The invention seems now to have passed the experimental stage and signals have been transmitted under water without difficulty through a distance of fifteen miles. It is well described by Commander F. L. Sawyer of the United States Navy in a paper read last December before the Society of Naval Architects and Marine Engineers in New York.

SAFETY, SALVAGE, AND TRANSPORTATION

As a consequence of the numerous and serious accidents which have befallen submarine boats of recent years much has been done to increase the safety of this craft. The hull is subdivided more minutely than formerly by bulkheads of sufficient strength to withstand the maximum water pressure. A buoy provided with telephone connection is fitted in the superstructure and can be sent to the surface in case of emergency, enabling communication to be established with the outside world. In some boats the men are provided with diving suits and helmets enabling them to escape or to remain for a longer time in the boat when it is flooded. Great precautions are taken to prevent the fumes from the storage battery from entering the working rooms of the boat. The battery is in many boats placed in an entirely separate airtight well-ventilated compartment.

Vessels of special type, "salvage docks," are built for the purpose of raising the boats when they have sunk to the bottom in damaged condition. Shackles are fitted on the top of the boats for this purpose.

Special vessels are constructed also for the transportation of submarine boats.

SIZE AND COST

From the moment that submarine boats were taken into practical service, claims to increased sea-going capability, speed, radius of action, and better living conditions on board were advanced by the naval officers. Those claims could be best met by an increase in size and we can understand, therefore, that size has steadily increased ever since the beginning of the century. Boats were then less than 100 tons fully submerged and are now being built of about 1,200 tons' displacement. The reason why the displacement has not increased much faster is chiefly the difficulty of providing suitable motors for propulsion of sufficient power. By an increase in size, moreover, the boats become more difficult to handle under water especially where the depth is small, but this difficulty is of secondary importance for ocean-going boats, which are likely soon to become a reality. The high cost of large boats will restrict their number, the price per ton being almost three times as high as for battleships.

MILITARY VALUE

The great military value of submarine boats has been demonstrated in the European war. At the present stage of development submarine boats afford not only the best means of defence of one's own harbors and coasts, but may be used also for offensive purposes in the open sea and on the coast of an enemy up to a distance of at least five hundred miles from their base. The large boats of from 1,000 to 1,200 tons' displacement now under construction will have a still greater effective radius of action.

It is characteristic for the submarine boat that, once it has gotten into position, it can carry out an attack with relatively small risk to itself. In this respect it differs radically from ordinary torpedo-boats which must be prepared for great and almost unavoidable sacrifices in order to carry out a successful attack. The greatest difficulty with a submarine boat is to bring it into position for attack because the speed is relatively slow. The initiative of the commanding officer, the training, endurance, and discipline of the crew as well as the condition of the boat and the machinery

The *Kangouroo,* French Transport Ship for Submarine Boats

count more in submarine boats than in other warships.

The development of the submarine boat in the future is likely to be gradual. In the meantime, it is probable that also the means of attack and defence possessed by the battleship against submarine attack will progress. Evidently, the first point for the battleship is to detect the submarine boat before it has reached within striking range. If this is successfully accomplished, the attack of the submarine boat can generally be avoided because its speed under water is relatively slow. Detection of a submerged boat is, however, a difficult matter, the only visible point being the head of the periscope which needs to be shown above the surface only from time to time. In still water the periscope is fairly visible by the wake which it makes on the surface when emerging, but in rough and misty weather it is extremely difficult to see. When the periscope is discovered, it will be at once subject to a hail storm of projectiles from light guns and, if it is hit, the boat will be blind and helpless. If, after that, the boat shows the conning tower above the surface, it will be generally exposed to destruction by artillery fire.

Detection from seaplanes and other types of air-craft is under many circumstances fairly easy and this mode seems to promise a great deal. These new engines of war may possibly become deadly enemies of the submarine boat by attacking it with bombs. When a boat is submerged it is quite helpless against such

attack. Even very light bombs are likely to prove destructive, and since the air-craft is in no danger of counter-attack from the submarine boat, it can go very low and hitting should not be a difficult matter. The submarine boat cannot even observe a seaplane when immediately over it. A further development of the seaplane is, therefore, likely to prove extremely dangerous to the submarine boat.

While the active or offensive means of defence are in this case as elsewhere the most effective, the battleship possesses means of defence of a passive nature such as watertight subdivision, elastic bulkheads and underwater armor, which may still be further developed, but experiments and war experience are required to throw light on the problems involved. The superior speed of battleships is of course in itself a means of protection. On account of the present limited range of submarine boats and perhaps especially on account of the limit to the endurance of the personnel, they do not render the powerfully armed and well-protected artillery ships superfluous. Fast sea-going battle-ships or battle cruisers are yet required in order to control the ocean, but as matters stand now, the smaller enclosed seas such as the Baltic, the North Sea, the British Channel, the Mediterranean, the Yellow Sea and other similar waters, may practically be controlled by submarines and by light, fast vessels. In the presence of an active enemy well provided with submarine boats large vessels cannot operate in such seas except under the greatest precautions, going at high speed and using all possible means for their defence. Merchant vessels fall an easy prey to submarine boats in such waters, their subdivision—even in the largest and best designed vessels—falling far short of that of warships.

VALUE OF OUR MINERAL PRODUCTS

According to the United States Geological Survey the value of the mineral production in the United States now exceeds $2,500,000,000 a year. This value, although falling far below the farm products of the country, can best be measured by comparison with other countries. The United States mines nearly 40 per cent. of the world's output of coal, and produced 65 per cent. of the world's petroleum in 1913. Of the world's more important metals 40 per cent. of the world's output of iron ore comes from American mines, and the smelters of the United States furnish the world with 55 per cent. of its copper and at least 30 per cent. of its lead and zinc.

HEAT TREATMENT OF COPPER AND BRASS

A CONTROLLABLE PROCESS IN THE PREPARATION OF THESE METALS WHICH VARIES THEIR PROPERTIES AND GIVES THEM A WIDE FIELD OF USEFULNESS

BY CARLE R. HAYWARD

THE mechanical properties of pure metal depend on three factors: First, general qualities inherent in the metal; second, properties imparted by mechanical treatment, such as rolling, drawing or forging; third, properties imparted by heat treatment, that is, heating to various temperatures and cooling at various rates. The first of these three factors admits of no discussion; copper can never be made the same as iron or lead, however it may be treated. The other factors are controllable and are of vital importance, for they may ultimately determine whether a metal is valuable or worthless.

What has been said above regarding metals is equally true of alloys, the usefulness of which depends not only on the composition but in many cases to a great extent on the mechanical work and heat treatment to which they have been subjected.

It is the purpose of this paper to discuss in a general way the effect of heat treatment on copper and one of its most important alloys, brass.

COPPER

Copper when cast has the crystalline structure characteristic of all cast metals. The arrangement of the crystals known as casting structure is due to the fact that the metal first solidifies at the outside, and the center is the last portion to become solid. Furthermore, the solidification and subsequent cooling have been so rapid that the crystals are likely to be in a state of strain. This radical arrangement of the crystals and their strained condition make the casting liable to break when subjected to severe stress. When copper castings are heated bright red a rearrangement of the crystals takes place and internal strains are relieved, thus improving the mechanical properties of the metal. By far the larger part of the copper in general use has been subjected to some mechanical work such as forging, rolling into sheets, or drawing into wire. This treatment hardens the metal and greatly changes the internal structure, by crushing and elongating the crystals. Fig. 1 shows a photo-micrograph of a piece of soft copper. The structure is developed by dipping in acid. Some crystals are attacked more than others and thus appear dark. After rolling, it had the appearance represented in Fig. 2. Note how the crystals have been distorted and crushed.

For many purposes it is desirable to retain the copper in the hardened state in which it exists after mechanical treatment, but in other cases soft and ductile material is preferred. Fortunately this state can be restored by annealing the metal at a bright red heat (about 700° C. or 1290° F.). This softening is accompanied by a decided change in the structure of the metal as shown in Fig. 3. It will be noted that the fractured particles of the original crystals have formed into new crystals and the material presents an appearance similar to the original structure before rolling. The size of the crystals depends on the temperature to which the metal is heated and the time it remains in the furnace. This is well illustrated by Figs. 4 and 5 which show the growth of crystals with temperature.

Quenching copper in water has a softening effect, the cause of which is not fully understood. Unlike steel, copper cannot be hardened or tempered by any method of heat treatment. The so-called lost art of tempering copper is a myth. Analyses of ancient copper implements show that they are in reality alloys of copper with

Fig. 1.—Annealed Copper.
Fig. 2.—Rolled Copper.
Fig. 3.—Rolled Copper Annealed at 750°C (1382°F).
Fig. 4.—Rolled Copper Annealed at 650°-700°C (1200°-1290°F) for 40 minutes.
Fig. 5.—Rolled Copper Annealed a short time at 900°C (1650°F). Fig. 6.—Cast Brass.

tin, arsenic or some other element which occurred mixed with the copper ore and became alloyed with the metal during the crude smelting operations. These substances have a hardening effect on copper and the hammering process by which the alloy was beaten into the desired form increased this property.

It is seen therefore that the heat treatment of copper is a simple process which consists in heating the metal to a bright red color thereby removing strains or hardness produced by mechanical work. Temperatures above 800° C. (1470° F.) should be avoided as the crystals become large and the metal is weakened.

The only way copper can be hardened is by alloying it with some other element or by rolling, drawing or forging it.

BRASS

Brass is an alloy of copper and zinc with sometimes small amounts of other elements to give it special properties. The relative amounts of copper and zinc vary in different brasses but except for special purposes the copper is between 55 and 70 per cent., and the zinc varies accordingly. When the copper is above 63 per cent., all the zinc present remains dissolved in the copper, and the solid alloy has a homogeneous structure with the general properties of a pure metal. When, however, the copper is below 63 per cent., the solid metal, when slowly cooled, contains two components, one of which is brittle and makes the alloy undesirable for many purposes.

Much that has been said regarding the heat treatment of copper is equally true of brass. Fig. 6 shows the microstructure of cast brass and Fig. 7 shows how the crystals have rearranged themselves on annealing. As in the photographs of copper previously discussed, the different shades of crystals are not due to differences in composition but to different degrees of etching. The growth of the crystals takes place in the same way as that of copper crystals. This is illustrated by Figs. 8–16. Fig. 8 shows the structure of a brass with 67 per cent. copper after annealing and Fig. 9 the structure of the same material after rolling. The effect of temperature on the growth of crystals is shown by Figs 10–12. The effect of time on the growth of crystals at constant temperature is illustrated by Figs 13–16.

Brass is hardened by rolling or drawing and softened by annealing. Spring brass is given its properties by rolling and would lose them by annealing. The rearrangement of crystals in rolled brass begins at 420° C. (788° F.) which is below the faintest red heat. Between 600° and 700° C. (1110° and 1290° F.) all internal strains and hardness are removed.

Care must be exercised when heating brass, not to allow the temperature to exceed 800° C. (1470° F.) as there will be danger of volatilizing some of the zinc contained in it, leaving the alloy porous.

The quenching of brass containing more than 70 per cent. copper makes little difference in its mechanical properties. With smaller amounts of copper, especially between 50 and 63 per cent. the slowly cooled metal is more brittle than the chilled material. This is due to the fact that chilling prevents the separation of a brittle compound of zinc and copper.

The above facts about copper and brass show that the heat-treatment of these materials is a simple matter compared with the treatment of steel, where slight differences in the temperature, time of heating, and rate of cooling may produce widely divergent results. If the steel has been overheated but not "burnt" the coarse structure obtained can be removed by reheating to a lower temperature. In the case of copper and brass, heat-treatment is merely annealing and the rate of cooling, except with brasses containing less than 65 per cent. copper, is of comparatively slight importance. If the structure is coarse, due to heating too long or at too high a temperature, the metal cannot be refined by reheating but must be subjected to rolling, hammering, or drawing which will break up the crystals. Reheating to the proper temperature will then soften the metal and relieve the strains.

In general it is true that fine-grained material is mechanically superior to that with coarse grains. For this reason care should be taken to anneal copper and

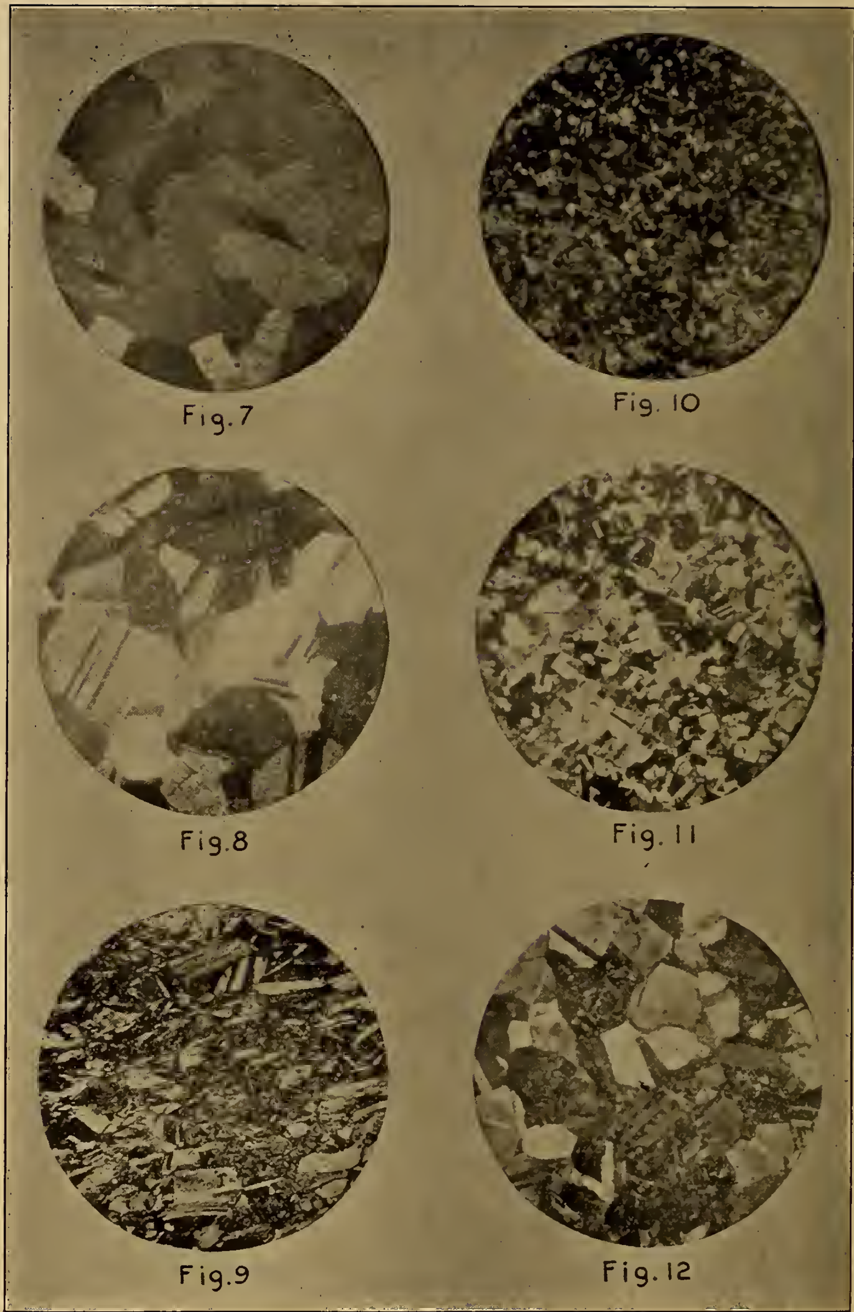


Fig. 7.—Cast Brass Annealed.
Fig. 8.—Annealed Brass.
Fig. 9.—Brass of Fig. 8 rolled.
Fig. 10.—Brass of Fig. 9 annealed 50min. at 425°C (797°F).
Fig. 11.—Brass of Fig. 9 annealed 50 min. at 500°C (930°F).
Fig, 12.—Brass of Fig. 9 annealed 50 min. at 600°C (1110°F).

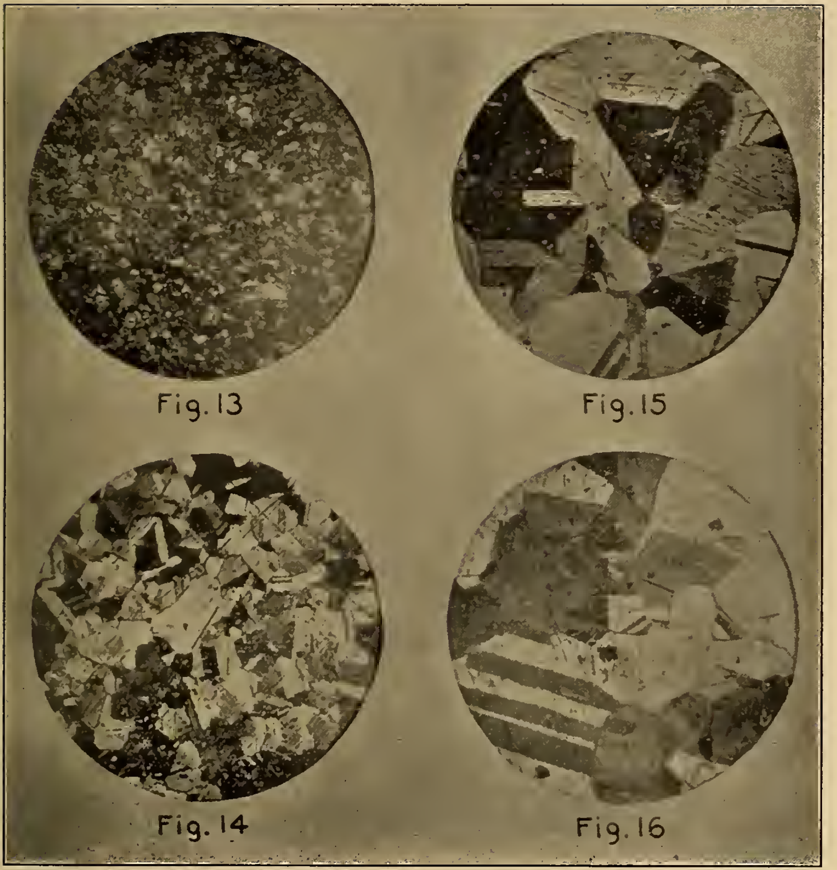


Fig. 13.—Rolled Brass annealed at 650°C (1200°F) for 15 seconds.
Fig. 14.—Rolled Brass annealed at 650°C (1200°F) for 40 seconds.
Fig. 15.—Rolled Brass annealed at 650°C (1200°F) for 2 minutes.
Fig. 16.—Rolled Brass annealed at 650°C (1200°F) for 15 minutes.

brass at the lowest temperature which will relieve the strains due to mechanical work. Higher temperatures will produce larger crystals. The proper temperature varies somewhat with brasses of different composition but, except in special instances, for either brass or copper, should not exceed the temperature given above (700° C.) and in most cases a lower temperature (600–650° C.) is preferable.

When it is desired to remove only part of the hardness the copper or brass may be annealed at a dull red heat for a short time, and even heating to a temperature just below dull red will sometimes suffice.

PROCEEDINGS OF THE ACADEMY

The Proceedings of the National Academy of Sciences, which first appeared in January, and of which the managing editor is Prof. E. B. Wilson of the Institute, has recently taken rank among the few indispensable scientific journals of the country. The aim of the journal is to furnish a comprehensive survey of the more important results of scientific research of this country.

Prof. A. A. Noyes, '86, and Dr. George E. Hale, '90, are connected with the publication of the journal.

THE NEWEST COSMOGONY

SUGGESTIONS BY DR. PERCIVAL LOWELL TOWARDS A WORLD ORIGIN THAT ACCORDS CLOSELY WITH THE KNOWN FACTS OF TODAY

BY JOHN RITCHIE, Jr.

An exceedingly interesting development from the work at the Lowell Observatory, Flagstaff, has been the setting forth of a new cosmogony by Dr. Percival Lowell. The purpose of the institution is for planetary observation, and while the intensely interesting announcements with reference to Mars have commanded the attention of the world, astronomical and layman, and have suggested to many that Lowell is mostly an observatory of Mars, this is by no means the case, and the other members of the solar system have constantly been watched. Some very interesting discoveries have been announced with reference to motions and appearance of the companions of the earth in the universe. It is but natural, therefore, that Flagstaff should have been greatly interested in the origin of the solar system.

The last few years have been fruitful ones in the development of hypotheses concerning the origin of suns and worlds. For a long time the ideas of LaPlace reigned supreme, but next there came a period of unrest with continual castings about for new suggestions that would accord with the newer facts. There was the planitesmal hypothesis of Moulton and Chamberlain, the segregation suggestion of Dr. T. J. J. See, variants on both of these, a return by Arrhenius to a position much nearer that of LaPlace and now that of Lowell, which in certain ways is different from any of the others.

The statement in brief of the Lowell hypothesis is this: The planets grew out of scattered material. Each one brought the next one into being by the perturbations that it caused in the scattered material at definite distances from itself, being, so to speak, the elder sister of the newer planet. Of the major planets Jupiter was the starting point and after it was formed there came Saturn, then Uranus and Neptune. The same is true of the minor planets, each being formed in turn in a place determined by the others. To use Dr. Lowell's own words, "The positions of the planets are not haphazard, but have been determined seriatim each by its predecessor, thus showing that the solar system is an articulated whole, an inorganic organism, which not only evolved, but evolved in a definite order, the steps of which celestial mechanics enables us to retrace."

What LaPlace taught was a bequest from the eighteenth century to the nineteenth, having been formulated with some diffidence during the closing quinquennium of the former. For nearly a century it satisfied reasonably well the needs of astronomers. The Nebular Hypothesis, for that was its usual name, had not any thought about origins in their more modern sense. It referred the solar system to no stellar collision, but merely assumed that there existed in the place where it afterwards formed a vast mass of glowing gas. This was more or less pancake in shape with a central condensation where the sun is now. The nebula was rotating and slowly cooling. In the shrinking process rings of material were formed and left at distances from the center which were approximately those of the planets of today, and these rings presently lost continuity and rolled themselves up into balls, the planets. The planets, masses of glowing gas, were themselves subject to shrinkage as they cooled and rings of matter were left behind which when they broke formed spheres, the existing satellites.

The unfortunate part of this hypothesis, according to Dr. Lowell in one of his

lectures half-a-dozen years ago, is that, while the facts known at the time were quite well cared for, the facts that have come to light since the hypothesis was formulated are most difficult to manage. In fact he voiced the opinion that if LaPlace were now alive and attacking the same problem in the light of modern knowledge, he would give a very different answer. There has been wide dissatisfaction in many quarters with the hot nebula, and astronomers have been more and more in favor of a cold origin for the earth. Then again there have been some who are bold enough to affirm that mechanics will not permit such a ring to roll up into a ball.

Ten or a dozen years ago, two Chicago men, Moulton and Chamberlin, put forth a hypothesis which attracted much attention and has today numbers of supporters. This goes back a step or two in origins and begins with a spiral nebula, the supposed cause of which was the collision or near approach of two great stars. The strains of a near approach would disrupt the two bodies and for a result two arms of loose material would be thrown out not unlike the rays of a slowly moving pinwheel. As would naturally ensue, the distribution of material would not be even and there would be knots or condensations here and there in the arms. As the result of the close approach the mass would have a motion of rotation about its centre of gravity. The knots would naturally draw to themselves through gravitation the material in their vicinity, and, in the revolutions, would really sweep the sky clear of the stardust that had been left there by the collision. There would of course be a constant rain upon the planetary surfaces of the loose material and the planets would grow in size. The smaller knots, which had sufficient independence to remain unconfiscated are the satellites and they, as well as the planets, have taken part in the clearing of the region of débris.

The pressure of the material that has come to the surface of any planet would of course generate heat and sufficient to account for the igneous phenomena of geology. The hypothesis is interesting for it makes a new geology in which the gradual cooling of the earth from a mass of glowing gas is to be found no more; atmospheres of carbonic acid gas are dispensed with and from the very beginning there have been sunny skies, gentle showers and meteorological conditions not very different from those the earth now experiences. And coming to the aid of the hypothesis, some geologists have found raindrops and other supporting records in the very earliest of the sedimentary rocks.

Something like four years ago Dr. Lowell made the first report of what his observatory has been doing in cosmogonies, and suggested one founded on the spiral nebula, with tidal action for the force that has gradually been reversing the poles of the planets, complete in the inner ones and in progress in the outer ones. But he had little sympathy with the cold process and claimed that it was a hot earth that is now cooling and that the major planets are still exceedingly hot.

Then in 1911 Dr. See set forth his views in a bulky volume. He outlined the situation and noted that there were only three solutions to the general problem: Detachment from a central body, which was what La Place had suggested; the capture by the sun of the planets already made, and the formation of the planets just where they are by aggregations of cosmical dust. These, he boldly says, are all the suppositions that it is worth while considering with reference to the formation of the solar system.

Dr. See next shows the impossibility of the Nebular Hypothesis, bringing in almost legal form seven or eight allegations against it. The details of his own suggestion can hardly be given in full here, but in brief the process is the forming of numberless spheres within the dust of a nebula, which in quantities went to the building up of the larger spheres. Myriads of them as large as the moon built up the sun, while the planets grew by accession of spheres already formed and not by the profuse rain of meteoric particles as held by the Chicago men. There was a good deal that was revolu-

tionary in the setting forth of Dr. See. He does not believe that the earth and moon were ever hot, or that the craters of the moon were ever really volcanic, and thinks that the earth must have had similar indentations, the record of the impact of some of the spheres already formed, but that they have been obliterated by the ocean. See will not agree with W. H. Pickering that the moon ever was part of the earth. "It is a planet," he says, "which came to us from the heavenly spaces and similar captures occurred in the cases of other satellites."

Then came Arrhenius, who, in a course of Lowell lectures three or four years ago, presented rather conservative opinions. He is, to a considerable extent, a supporter of La Place, but finds his planets in great comets or dark spheres that came from space, penetrated the solar nebula, became enmeshed in it and have settled down to regular, orderly orbits about the sun. Of course they have had their part in sweeping the space of its nebula. Unless Dr. Arrhenius was misunderstood at his Boston lectures, he claimed that the moon and other satellites were secondary captures of comets, being taken not by the sun but by the individual planets which hold them.

In his cosmogony Dr. Lowell now begins not with the spiral nebula but with the planetary form. In the former there are two great arms, the results of the stresses of near approach, and there are knots or condensations in them which are what some believe to be the nuclei about which the planets form. The planets grow by gathering to themselves the fragments of nebula lying near their paths. An objection to the spiral nebula suggestion, according to Dr. Lowell, is that such an origin would be likely to produce planets in pairs on account of the probable symmetry in the knot-positions in the two arms. On the contrary the original solar system nebula must have been of the so-called planetary form with a central condensation, a fairly even distribution of material and a motion of rotation. Everything is here in motion, the central condensation which is to develop into the sun and the particles of the plenum, the latter, indeed, having each one its individual revolution about the center of gravity of the whole mass.

But the distribution never by any possibility can be even, so that there will infallibly be local gatherings of material. Any one of these will exercise influence over the particles in its vicinity, drawing them to itself if they are near and collecting them in all parts of the orbit, so that the sweeping of the path of the growing planet will be effected. The sweeping will be done throughout a zone within which the attraction is sufficiently strong to bring the particles to the planet.

Outside this region the attraction will effect a perturbation of the particles, which, while disturbed somewhat, will continue in nearly their former orbits. The effect of the perturbation must be to introduce an influence, perhaps best expressed as a "jostling," which causes the particles to collide, to interfere with one another's motions, to lose headway and in short to gather a group of particles which will form the nucleus of a new planet.

This is what Dr. Lowell means when he says that "so the process goes on, each planet acting as a sort of elder sister in bringing up the next." As soon as a planet is formed, it begins to call into being another one beyond it, and the latter could not begin earlier because the fundamental factor, the perturbation of its predecessor, was lacking.

The mathematics to support his position are given quite at length by Dr. Lowell in his original presentation,* attention being given to certain potent periodic rates, $1/2$, $2/5$, $1/3$, expressive of the mean motion, and suggestive of proportional commensurability in the major axes of the orbits of the planets.

In an interesting way, Dr. Lowell presents some of the arguments in favor of his hypothesis. He adduces the fact that the planets are not in their precise computed places, but to sunward of these as an additional argument, showing the existence of similar perturbations of a different order. He finds also that the

* Memoirs of the American Academy of Arts and Sciences, XIV, 1.

asteroids point "unmistakably" to such a genesis, missed in the making. Jupiter lies very close to the original starting point of the planetary evolution and was the first of the planets to form. If Neptune had been the first, it would now have the greatest density, followed by Uranus, Saturn and Neptune; whereas the densities are now in the opposite order, save that Saturn has a low figure. Dr. Lowell finds further that the inner planets support his rule of commensurate period points and dovetail into the major ones through the $^2/_5$ relationship between Mars and the asteroids.

SPRAYED METAL COATINGS

During the last two years a new method of producing a thin coating of metal on miscellaneous articles has been perfected that has possibilities beyond any previous methods. The apparatus which is used in producing this coating is on the principle of an atomizer. The metal with which the object is to be coated is introduced into the machine in the form of a wire. It is melted by mixed gases, and at the same moment is blown upon the object to be coated by a blast of compressed air. The molten metal is carried from the spraying machine in a finely comminuted molten condition and is fixed upon the object in a smooth, compact surface adhering tenaciously to the surface and penetrating into the most minute crevices. The method is known as the Schoop process.

The metals that have been tested with satisfaction are lead, tin, zinc, aluminium, brass, copper, bronze, nickel silver; while gold and silver, although amenable to the process, have not yet been fully exploited. The film deposited by the spray may be as thin as one one-thousandth of an inch.

Some curious phenomena have been brought out by this process. While the temperature at the apex of the cone of the spray may be 700° to 2000° F., at a distance of three, four or five inches away, combustible materials may be coated with the metal without danger of being burned. The heads of matches can be metalized by the Schoop process without being ignited, tissue paper can be surfaced with it, and the finest silk has been metalized without injuring its texture.

AIR TO THE RESCUE

An interesting and novel method of floating a ship that had forced herself into the mud nearly three feet above her light-load line was used on the steamship *Zeeland* in the St. Lawrence River. Two holes were bored in the inner end of fourteen brass drainage plugs which were already in the ship's bottom plating, having been put in from the outside. Key wrenches were fitted into the newly drilled holes and the plugs were released by unscrewing them outward. Threaded pipe connections were instantly screwed into the holes, and a rubber hose leading to an air compressor was attached. Then a stout wire hawser was looped around the bow of the liner, each end being led to a securely moored dredge where it was passed around the drums of powerful winches. In addition lines were led to tandem tugs, representing 14,000 horse-power. The ship was lightened all possible and then the compressors were put to work. The escaping air broke the seal between the bottom of the vessel and the adhering mud, and in a very short space of time the liner was towed off into deep water.

NORTHEAST STORMS

Many of our readers will be surprised to learn that what we know here in the East as northeast storms do not in reality come from the northeast at all. The storm itself comes from the west or southwest, usually along a well-recognized track, and the strong northeast rain-bearing winds, which drive the rain to the ground as from a northeastern direction, are simply the indraft of a barometric depression in the reverse direction. It is very rare that a storm in these latitudes travels from the East to the West. Such storms are called "flarebacks" and are the despair of weather forecasters.

PLANTS AND ANIMALS DISTINGUISHED

Had we been given the problem of starting life upon the surface of this earth, our first care, after receiving the impetus with which to set life moving, would be to get a source of energy which could be stored in reservoirs suitable for tapping at will. We would soon find the only practicable source to be the light of the sun. The problem then would be to convert the sun's rays into a form suitable for storing and tapping at will. This problem life has solved through the agency of chlorophyl, the green coloring matter of plants. This chlorophyl is the factory in which the sunlight works, breaking up the CO_2 into C and O, and recombining these atoms with some products derived from the soil into starch. In other words, the kinetic energy of the sun's rays is transformed into the potential energy of starch and in this form becomes the reservoir capable of being tapped at will for movement, reproduction, or other needs. There is considerable reason for believing that an early form of life combined in itself the power of storing up energy and of expending it in free movements. For some lowly forms, such as the free-moving, microscopic, one-celled organism Euglena, still exist which through the presence of chlorophyl are enabled to manufacture starch.

In such a form the plant and animal kingdoms merge their characters to such an extent that it is impossible to classify it as definitely either plant or animal. Similarly upon hardly any other theory than the former union of the plant and animal kingdoms can we account for the difficulty of making a definition for the one which will be exclusive of the other. There are exceptions to almost every statement made in defining them. If, for example, we arrange such definitions in parallel columns this conclusion will be easily seen.

PLANTS

1. Take food from the inorganic and convert it into organic, as starch, proteids, etc. (Exceptions—fungi, bacteria, etc., live upon organic material.)
2. Chlorophyl present. (Absent in many parasitic forms as dodder.)
3. Cellulose present.
4. Without power of locomotion. (Spores of some algae have locomotion and contractility but later become fixed. Many higher plants, as honey locust, clover, etc., have contractility prominently developed.)
5. Eat by absorption.
6. Make use of CO_2 and some oxygen.
7. Excrete O, and CO_2.
8. Have no definite number of organs.
9. Have unlimited growth (except many fungi, etc.).

ANIMALS

1. Feed upon organic matter.
2. Chlorophyl absent. (Present in some protozoöns.)
3. Cellulose absent. (Present in some protozoöns and very abundant in the ascidians.)
4. Locomotion more or less free.
5. Have mouth and digestive canal. (Some very low or degenerate forms eat by absorption.)
6. Make use of oxygen.
7. Excrete CO_2 and urea.
8. Have definite number of organs.
9. Have limited growth (except many sponges, corals, etc.).

To this may be added that both plants and animals respond to external stimuli, are affected by narcotics, become fatigued after repeated stimuli from which they recover upon rest, sleep once a day and upon death cease exhibiting these conditions.

If, as this similarity makes probable, both organic kingdoms were at first united in a generalized type capable both of storing energy and of expending this energy in free movements, this union within the same individual was soon found to be incompatible and part of these generalized organisms, which were neither plant nor animal, chose the line of energy storing and part that of using this stored up energy in free movements; the former developed into the Vegetable Kingdom, the latter into the Animal Kingdom.

It is better then to define these two kingdoms, through the characters upon which each lays special emphasis. Plants lay emphasis upon immobility, animals upon mobility. If the two kingdoms are thus defined with the attendant consequences, the following diverse conditions result. Plants in choosing the life of energy-storing were sure of their food but as a result they became immovably at-

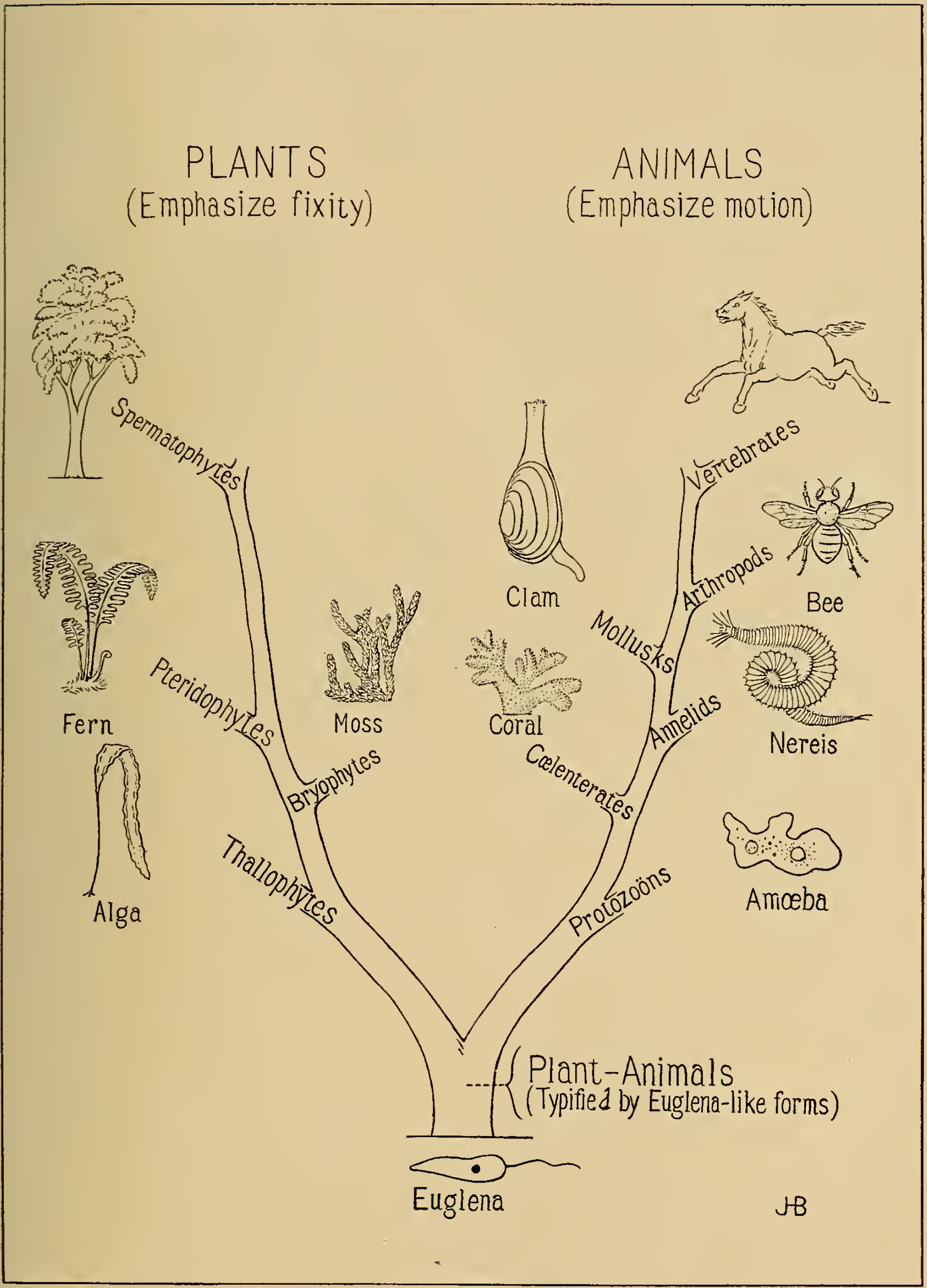


Diagram to illustrate the initial division of the life force into plants and animals and its repeated further branching into progressively higher and higher phyla. Only six of the twelve phyla of animals are represented.

tached to the earth and developed hard parts (cellulose or woody fiber) for the protection of the soft protoplasm, as a result of which protection, stimuli from the external world could penetrate with great difficulty. Owing to this lack of stimuli plants remain very low in consciousness (self-consciousness not meant). Animals, on the other hand, in choosing the more hazardous life of searching for manufactured food had to remain more or less free and as a result of this necessity for continued movement could not surround themselves completely with a hard skeleton. Consequently stimuli from the external world could penetrate with comparative ease and these stimuli have caused the development of a higher and ever higher consciousness with all its attendant nerves and body organs. All these divergent characteristics have followed as a natural consequence of the first choice.

H. W. S.

WHEAT CRISIS COMING

In his presidential address to the British Association at its meeting at Bristol in 1898, Sir William Crookes gave some valuable estimates of the world's supply of wheat, which, as he pointed out, is "the most sustaining food grain of the great Caucasian race." Founding upon these estimates, he made a forecast of the relations between the probable rates of increase of supply and demand, and concluded that "Should all the wheat-growing countries add to their (producing) area to the utmost capacity, on the most careful calculation the yield would only give us an addition of some 100,000,000 acres, supplying, at the average world yield of 12.7 bushels to the acre, 1,270,000,000 bushels, just enough to supply the increase of population among bread eaters till the year 1931." The president then added, "Thirty years is but a day in the life of a nation. Those present who may attend the meeting of the British Association thirty years hence will judge how far my forecasts are justified."

In his address before the Geographical Section of the Birmingham meeting of the British Association in September, 1913, Professor H. N. Dickson refers to Crookes' prophecy and says, after quoting a mass of statistics, "We gather, then, that the estimates formed in 1898 are in the main correct, and the wheat problem must become one of urgency at no distant date, although actual shortage of food is a long way off."

ENDLESS MAGNETIC CHANGE

In an essay on terrestrial magnetism John F. W. Herschel said:

"The configuration of our globe—the distribution of temperature in its interior, the tides and currents of the ocean, the general course of winds and the affections of climate—whatever slow changes may be induced in them by those revolutions which geology traces—yet remain for thousands of years appreciably constant. The monsoon, which favors or opposes the progress of the steamer along the Red Sea, is the same which wafted to and fro the ships of Solomon. Eternal snows occupy the same regions and whiten the same mountains, and springs well forth at the same elevated temperature, from the same sources, now, as in the earliest recorded history. But the magnetic state of our globe is one of swift and ceaseless change. A few years suffice to alter materially, and the lapse of half a century or a century, to obliterate and completely remodel the form and situation of those lines on its surface which geometers have supposed to be drawn in order to give a general and graphical view of the direction and intensity of the magnetic forces at any given epoch."

LOCATING BURIED NEEDLES

G. H. Monks, in the *Boston Medical and Surgical Journal*, describes an interesting method of locating needles buried in flesh tissues. The buried needle is magnetized by passing a magnet over the tissue where the needle is supposed to be located. Another needle, suspended from a fine silk thread, will have one of its poles attracted to the opposite pole of the buried needle, and its location may thus be determined with accuracy.

Science Conspectus

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NOTES FROM A VOLCANO LABORATORY

THE "PERSONAL DOCUMENTS" IN THE CASE OF KILAUEA AND MAUNA LOA, AND HOW THEY ARE TRANSLATING THE LAWS OF EARTH ERUPTIONS

BY T. A. JAGGAR, JR.

In the popular mind, an active volcano is supposed to be the most disorderly and haphazard thing imaginable. But when, at the suggestion of business men in Honolulu, the town of Hilo in 1912 subscribed the money to build an Hawaiian volcano observatory at Kilauea, there was evidenced a scientific spirit in the community far in advance of the popular conception. It became the function of the new observatory to study the two active volcanoes, Mauna Loa and Kilauea, from year to year as closely as possible with a view to finding out, apart from all prejudice, whether the gases and lavas come out, from the earth's interior in some orderly pulsations or otherwise. The gradual growth of the science of volcanology, from an historical history of disaster, has been well begun in Italy, Japan and elsewhere since the terrible catastrophe of St. Pierre in Martinique in 1902, and the foundation of the Hawaiian Observatory was a sound step in advance. It is my purpose to show here certain orderly results of three years watching and to urge the necessity of extending our facilities so that the summit crater of Mauna Loa will be more accessible.

In spite of hard times and hard prospects, the scientific work on the volcano has received encouragement from the community. The Hawaiian Volcano Research Association has been organized and anyone who is interested may join and receive the weekly bulletins which tell of the progress of the volcanic activities at Kilauea. We have members in Europe, United States, Central and South America and Japan. The Massachusetts Institute of Technology is a large subscriber and contracts to carry on the scientific work of the association. Co-workers have made important experimental studies here who have come from Italy, Switzerland, France, England and United States. We have taken part in the investigating of the great disaster of Sakurajima in Japan by sending an expedition hither. The leading business firms of these islands have subscribed to the scientific work being done here and the officers and directors of the Society have been leaders in the educational and commercial life of Honolulu; while Hilo took an important part in the initiation of the work, it is to be regretted that the Research Association has not more Hilo members and it is hoped that a substantial addition to the membership list will soon be made through the increased interest of persons living on the Island of Hawaii. For surely the inhabitants of this island have every reason to take an interest in the fires beneath their feet.

For three years the observatory at Kilauea Volcano, under the scientific direction of the Massachusetts Institute of Technology, has recorded the rise and fall of the lava in the pit of Halemaumau, has mapped the outline of the lava pool, has noted the nature of the activity and the temperature of some of the gas vents, while the seismograph pendulums in the basement of the Observatory have written, from second to second, a story of the local earthquakes and the tiltings and tremblings of the ground, and the meteorlogical instruments have made similar records of the rainfall, humidity, temperature and pressure of the air.

ROCK TIDES

It has long been known that the crust of our rocky globe rises and falls with a tide similar to that of the ocean. Like the latter, this slow creaking wave that passes through the rocks to a depth of many miles is occasioned by the pull of the sun and moon acting upon the revolving earth. The earth bulges somewhat in a zone around the equator and every month the moon moves north and south of the equator while the sun does so only every year. Each half year the sun reaches its farthest south or its farthest north, while the moon does so each half month. These great celestial swings make a squeeze upon the bulging crust of the equatorial belt over and above the normal tides which depend upon the daily rotation of the earth and the conjunction and opposition of sun and moon, popularly known as the times of new and full moon. There are other factors such as the times when the sun and moon are respectively nearest to the earth which modify the daily, semi-monthly and semi-annual squeezes which are crunching the rock crust on which we live, and a diagram showing all the complications of tidal theory and its effect at any point on the globe no one living is at present competent to construct. But from direct experiment, Professor Chamberlain, geologist, and Professor Michelson, physicist, of the University of Chicago, have recently proved a tidal movement in the solid earth, up and down, of about a foot twice each day and varying in amount through the lunar month and the solar year; and more than twice as great in a north-south direction as east-west. It is easy to understand how important such a movement is here in the equatorial belt of the globe where relatively small cracks going down forty or fifty miles are filled with liquid lava between walls of rock subjected to this rise and fall as well as to sidewise pressure, that is, to the passage of earth waves.

With knowledge of this ebb and flow in the rocky shell of the globe, we would expect careful measurements of the rise and fall of the lava column of Kilauea to show some kind of daily tides, some monthly change and a maximum every half year. Beyond this, in terms measured in years and centuries, there should be greater crises of some sort but in how far they should be tidal and how far dependent on the construction of the volcano is at present unknown. By construction of the volcano, I mean the building up of inner cones by lava overflow so as to confine the otherwise steadily rising lava column, as is the present case with Halemaumau, and complications of hot gas and congealing lava underground which may determine the relationships of Mauna Loa and Kilauea.

There is definitely a daily movement marked by a maximum and minimum of lava level in Halemaumau every few hours and there seems to be a tendency to marked rising about noon and midnight, the times of maximum barometric pressure. There is also a pulsating movement which I once recorded for twenty-two hours (in January, 1913) making a measurement once an hour of the height of the lava surface. The lava as a whole was rising, but the record showed a succession of quick jumps followed by slow sinking for three or four hours, each jump happening within the course of an hour and rising to a point slightly above that of the last previous jump. This jumping movement was probably occasioned by gas accumulation and release, while the net rise in the course of a day may have been tidal. It is to be hoped that some

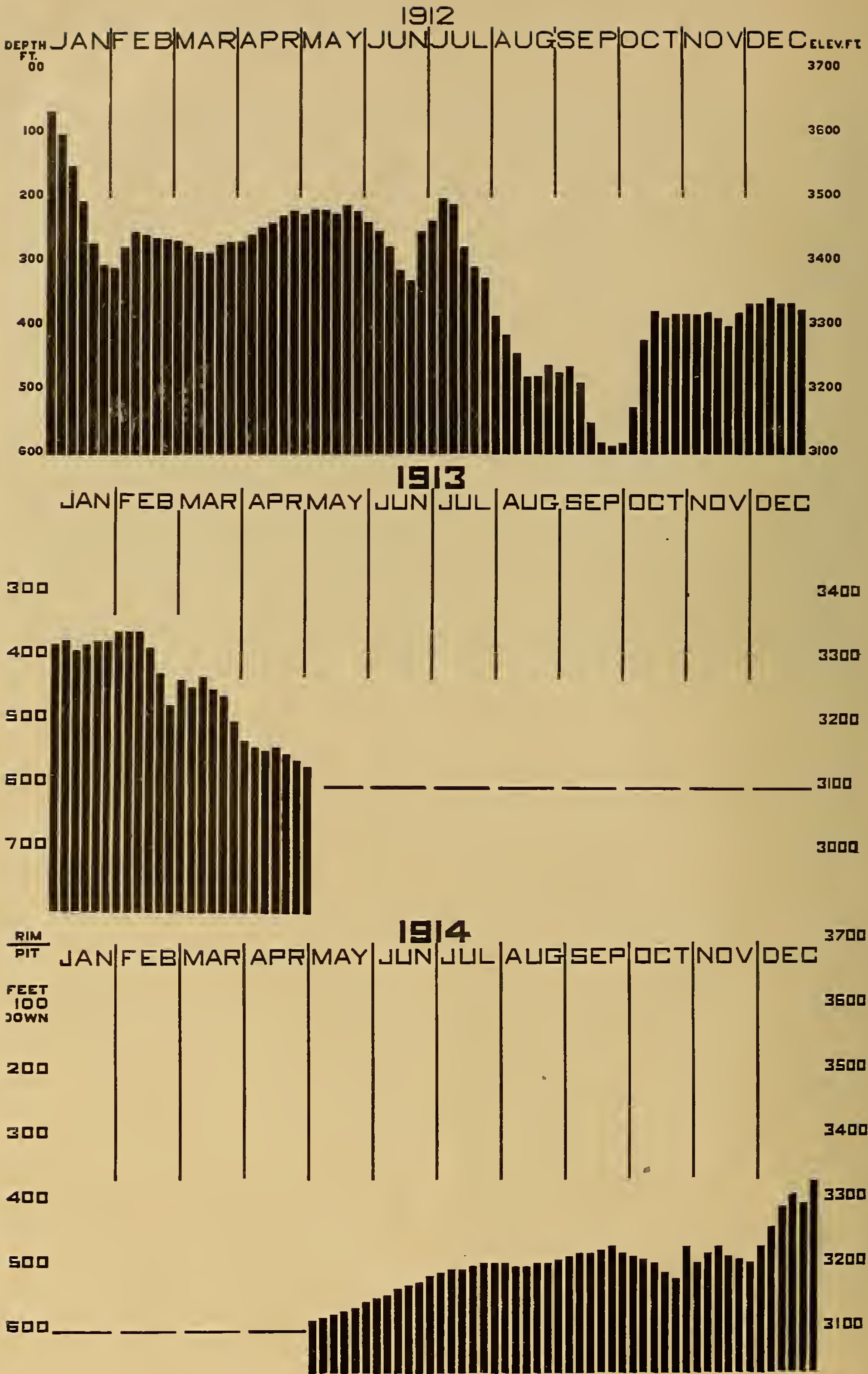
Hawaiian Volcano Observatory from the northeast

day we shall have the means during a time of high activity of Kilauea to keep a staff of assistants at work with a transit on the edge of the pit every fifteen minutes throughout a lunar month, and thus construct a diagram showing the details of tidal movement. This would necessarily be more expensive work than is now possible.

Diagrams have been prepared to show for the years 1912, 1913 and 1914 the rise and fall of the surface of the liquid lava measured from the edge of the pit Halemaumau, which is at an elevation of 3,700 feet above sea level. The average height of the lava for each five days has been shown as a black vertical line drawn with reference to a scale of depths below the rim of the pit indicated on the side of each diagram so that the tops of the black lines fluctuate in height in accordance with the measurements. From left to right across the diagrams are monthly divisions, each month of thirty days being represented by six of the vertical lines or columns, and the fluctuation in height to the top of the columns thus expresses for each month graphically the fluctuation of the lava.

These diagrams, beginning with January 1912, reveal on the whole a gradual sinking of the lava throughout that year and until May 1913, when the pit became so smoky and the lava sank so low, that for just one year no accurate measurement was possible. The year in question was from May 1913 to April 1914, when the lava was in general over six hundred feet below the rim of Halemaumau. From May of 1914 to the end of that year, the lava gradually rose but not so high as previously, and then from January 5, 1915, to the end of March 1915, it has gradually been sinking until it is more than five hundred feet below the rim of the pit.

Examining the details of these diagrams from month to month, it is easy to see that every month there is a distinct bend in the movement of the lava. The



Record of rise and fall of lava in Halemaumau

lunar month contains twenty-eight days and therefore does not check perfectly with the calendar month. Allowing for this, we find that there are thirteen crises in the year 1912 about a month apart, as follows: December–January high, January–February low, February high, March low, April–May high, June low, July high, August low, September high, September–October low, October high, November low, December high. The incomplete diagrams of 1913 and 1914 show similar features and it becomes clear from a study of these diagrams that there is a complete rise and fall of the lava column, a flow and ebb, every two lunar months. In general, rising takes place faster than falling, though this is not invariable.

We next come to a very marked characteristic of the movement of the Kilauea lava column; namely, the semi-annual high level. That this is connected with the change in declination of the sun north and south of the equator seems probable because both the changes in the sun's angle and the rise and fall of the lava are gradual and the quarterly culminations correspond. The 1912–1913 diagrams show high level (1911) November–January, low level February–April, high level May–July, low level August–October, high level November–January, low level February–April. The high levels are times of solstice, the low level times of equinox. This movement became so definite that it has been used during the past year for prediction, and the December rise of 1914 was expected. The prediction stated that there would be a fall in January 1915 and thereafter, and these things have come true.

There are thus short- and long-period movements of some regularity within a single year and these are gradually being verified by the accumulation of records for several years. The rising and falling of the Kilauea lava column is a sensitive index of the addition or subtraction of hot gases to a much larger mass of liquid deep in the earth and is also a sensitive measure of any compressing together or opening apart of the walls of the larger lava chamber underground to which the pool in Halemaumau is merely a small window. Geologists think that the lava comes from a potentially molten substratum at least fifty miles down and probably the passage leading down to this large mass of lava is nothing more than a crack or fissure. Kilauea has been built as a cone by the overflow of lava above this crack and this overflow has built up a central hole and radiating flows so that the lengthwise trend of the fissure beneath is entirely masked by the mechanism of a central pit above. Squeezing together the walls of a fissure containing liquid which opens into a small tube above will cause the liquid to rise and fall in the tube, and something of this sort takes place when a tidal squeeze warps out of shape the whole body of the earth, be it ever so slightly. As only three years of measurement have yielded such important results, we may expect that a half century of work at the Hawaiian Observatory will create a new science. The work must go on, it must unceasingly increase in accuracy of method and completeness of record, and it must be extended to other volcanoes around the Pacific Ocean for comparative results.

LONG-TERM ERUPTIONS

Even with the casual notes of travelers and scientific men made since the time of Vancouver's voyage in 1794, it is possible to glimpse something of the meaning of the relationship between Kilauea and Mauna Loa and of the long-term happenings at Kilauea which are marked by tremendous cataclysms. There have been two such catastrophes at Kilauea in historic times, the explosive eruption of 1790 and the tremendous earthquake of 1868. In both cases there was collapse of the bottom of Kilauea crater, and afterwards a new period of building up the bottom by means of lava overflows. We know nothing of what sympathy Mauna Loa may have shown with the 1790 explosion, but we know positively that Mauna Loa shared in every way in the earthquake and lava flows of 1868.

For Mauna Loa the 1868 crisis inaugurated lava flows at the south end of

Technology Station, Instrument Hut and A-frame, Halemaumau lava pit, Kilauea Volcano, north edge

the mountain and since that time the eruptions of Mauna Loa have happened about once in ten years with flows alternating north and south. The 1868 flow was south, that of 1880 north; the 1887 flow was south, that of 1899 north; the 1907 flow was south and accordingly the flow to be expected from the present eruption about ten years later, say 1917 or 1918, should come from the north.

The outbreaks of Mauna Loa every ten years or so, beginning with gas-lava fountains at the summit and ending with lava flows from the flanks of the mountain, seem to mean that some great force tends to steadily push gas and lava out of the mountain, while a restraining structure, the great slag heap of the mountain nearly 14,000 feet high, confines the lava within the oven so built up, and compels it to erupt in spasms—at intervals instead of continuously. There is some reason to think that all volcanoes have passed through stages from free-flowing continuous lava emission to greatly confined gas-lava explosion.

Kilauea Volcano is not so high as Mauna Loa, and after its evisceration in 1790, the lava, with many blowing cones and poolings within the crater, began to overflow and construct there a floor which was slowly built up into an inner cone; this cone-building by overflow being continuous throughout the nineteenth century until 1894 except for temporary interruptions by lateral outflow to the sea in 1823, 1840 and 1868 and possibly 1887. From 1894 to the present time, Kilauea has failed to overflow the inner Halemaumau cone and this period of twenty-one years, more than a fifth of a century, must be an important episode in the approach toward another great

Strong motion Seismograph Whitney Laboratory of Seismology

crisis like those of 1790 and 1868. Both Mauna Loa and Kilauea have shown diminution of volume of lava poured out from 1790 to the present time.

VOLCANIC SYNCHRONISM

It has frequently been asserted that there is no sympathy between the activities of Mauna Loa and Kilauea. This statement seems to me a loose one, unsubstantiated by facts. If there were a deep-seated connection somewhere between the surface of the earth and the substratum fifty miles down whereby both the Mauna Loa and Kilauea lava-gas columns come together, and the mechanism of the rising and falling columns is dependent on a squeezing earth crust and on hot gas which maintains a heat circulation in a liquid subject to rapid congealing, then we are not to look for any hydrostatic balance between the two columns. We have clearly to do with an uprising stream of liquid on each side of the system, that is in Mauna Loa and in Kilauea respectively which is restrained by its own tendency to solidify above when chilled, and is maintained by the release of hot gas and lava under pressure from below. If one of the two vents suddenly split open wider and so released to the air lava and gas under pressure, the other vent might be expected to be robbed of heat and of expanding gas and consequently to congeal and its lava to subside. It might well be that for a time, in the case of the sudden opening of one of the vents, the other vent would show a sympathetic kick or rise in the lava followed by subsidence as suggested above. The evidence of sympathy, therefore, in the behavior of the two vents would be complex and would depend on the sizes and heights of the orifices, the source and mechanism of the heat supply, the depth and size of the connection between them and the volume and pressure of the foaming body of lava available for the particular eruption in question. This last factor is doubtless dependent on the time interval which has elapsed since the last eruption, in the case of a volcano like Mauna Loa, if we suppose the succession of eruptions to be the spasms of a steadily accumulating fluid which tends to escape.

The records of the nineteenth century are too incomplete, especially as concerns the stagnant times at Kilauea, to give us any clear evidence as to whether Kilauea lava went down when Mauna Loa lava came up and vice versa, as might be expected from the above analysis. The record of the last thirty years, however, suggests such a relation.

After the Mauna Loa outflow of 1887, there was revival and vigorous activity of Kilauea culminating in 1894. During this time Mauna Loa was quiet. Kilauea lava subsided and disappeared after 1894 and Mauna Loa revived in 1896 and poured out lava from the Dewey Crater in 1899. Kilauea showed a little life but at a very low level in 1900 to 1902 and Mauna Loa remained quiet. Mauna Loa became active in 1903 with outflow in 1907 and Kilauea remained quiet. Kilauea revived rapidly after the Mauna Loa flow of 1907, rose to its highest level three years later in 1910, remained high for the three years 1910 to 1912, and sank slowly as shown by our diagrams from 1912 to 1914. During all this time Mauna Loa remained quiet. In 1914 Mauna Loa revived and at present, 1915, Kilauea is subsiding, to what end remains to be seen.

This sequence of events suggests a more or less periodic eruption of Mauna Loa about once in ten years and Kilauea activity during the repose periods of Mauna Loa. These ten-year periods are probably controlled by influences of lava accumulation and release rather than by any tidal strains. It may well be, however, that in the critical time of approach to the end of a repose period that an exceptional tidal stress in the crust of the earth will act as trigger to release an eruption. Other crises at still longer intervals in the history of these volcanoes are very likely always accompanied by sympathetic displays in both volcanoes, as in 1868 when the sympathy was unquestioned and in 1790 concerning which the accounts are very meager; we know nothing whatever of

Alex Lancaster (left) and W. O. Wood (right) summit crater of Mauna Loa, December 15, 1914. Smoking lava fountains in the background. The Observatory Expedition

Mauna Loa or of the earthquakes and lava flows of that time.

CRITICAL STRESS DATES

Where there is accumulated stress underground from gas or lava pressure, it has been above suggested that the critical times of tidal squeeze, summer and winter, may act as trigger to release the gas or liquid and start an eruption. There are some dates when the earth squeeze is unusually strong, and these dates do not recur every year as they are dependent on coincidence of several variable relations of the sun, moon and earth. Thus either sun or moon may be at their nearest points to the earth, both may be farthest north or farthest south of the equator in their periodic swings, and they may be pulling together on opposite sides or on the same side of the earth. It is rare for all of these extreme positions to occur on the same day, but there was such an occurrence January 4, 1912, the time of the very highest rise of the Kilauea lava column shown in our diagrams. Also on the same day, the tide gauges in Hawaii showed the highest ocean tide ever recorded on them. The reason was that moon was farthest north and sun was farthest south, both were nearest to the earth and the moon was full; that is, it was pulling on the opposite side from the sun. Events of the year, of the half year and the month conspired on one day to make a rare event of combination which only happens at long intervals. It can be easily understood that such a day of unusual stress on our globe would press the button to start explosion or earthquake if volcano or straining earth crust were ready to be touched off.

Lake of molten lava, February, 1913, interior of lava pit, looking down from the east

TYPICAL VOLCANIC ERUPTION

Science is still very ignorant about volcanoes and about the physical chemistry of hot lava filled with gas. Laboratory and field studies are working together, however, in demonstrating that the course of typical volcanic eruptions is everywhere the same in kind, differing only in degree; some volcanoes showing dominantly explosion and gas, while others are comparatively quiet with liquid lava as their chief product. Without discussing here the complex reasons for what happens, which would take us far afield, it is generally agreed that a typical eruption proceeds as follows:

(1) Unusual earthquake strain near the volcano for days, weeks or months with an abnormally large number of small earthquakes and some strong ones.

(2) A foamy lava rushes upward with a cracking open of the mountain through the central crater, the foaming being due to the gases contained in the fluid, very hot and very greatly compressed. According to the intensity of this gas pressure, the eruption may be a tremendous explosion which blows the lava foam to dust, or it may be a violent foam fountain with oxidation of the combustible gases making flames. The first case is that of Sakurajima or Vesuvius, the second that of Mauna Loa. The rise of the lava foam in any volcano follows upon a longer or shorter term of rest and in general, the longer the term the more explosive the outbreak. Like volcanoes are apt to have like terms of repose and the length of these quiet intervals appears to be one of the distinctive characters of a given volcano, though some volcanoes are much more regular than others. Given an average repose period drawing to a close for a particular volcano, and numerous earthquakes marking the underground stress, we can look for an eruption as most likely to come near the solstice, or on some date when the celestial tide strain is strongest.

(3) The adjustment of gas to liquid underground, a complex relation little understood at present, next takes place through the escape of large quantities of gas in the form of bubbles rising through the liquid, and if the upper part of the lava column is in any sense a froth, then this froth or foam may be conceived to sink or settle down as its bubbles burst. The gas itself, imagined to be contained in solution in the lava far down, passes from the dissolved to the bubble stage somewhere in the depths and thereabove expands and rises with dissociation and some chemical reaction which have various cooling and heating tendencies, the net result of which is volcanic eruption. Until these processes are imitated in the laboratory, science will know little about them, but the actual observation of volcanoes demonstrates without question that gas rushes forth for days or weeks after the first outbreak. This outrush may gradually decline, or it may be periodically renewed as though pulsating under alternate confinement and release. The term of gas escape before the liquid lava flows may be short or long, measured in hours or in years. There is no hard and fast line between explosive lava and liquid lava, and in a sense, the lava flows from the instant that a volcano begins exploding; the transitions between explosion clouds, foam fountains, frothy flow, lava flow and the rise of stiff lava plugs is represented in all gradations in different volcanoes and sometimes two or more of these processes are simultaneously at work in different parts of the same volcano.

(4) The liquid lava rises and escapes from the volcano in some form of lava flow and this stage is generally sharply marked as a term of days or months when the mobile melted rock is either welling up in the summit crator and higher, like a stiffening dome of very viscous slag, or the mountain rifts open along some ancient fissure and the liquid lava, perhaps spurting at first to the summit crater for a temporary display, finally makes a new crater lower down and pours a flood of melt for days or months down the flanks of the volcano in accordance with the habits of such volcanoes as Etna and Mauna Loa. The first type mentioned, with the stiff

Mauna Loa eruption from the northwest, November 27, 1914, third night of the eruption. Camp ground at Puu Lehua shows rapid decadence of the eruption

dome rising above the crater, is now known to be common in the West Indies, Aleutian Islands, Japan and elsewhere, but was unknown to geologists before the eruption of Mount Pelee in 1902. This escape of lava is the culminating achievement of volcanic eruption, that for which the eruptive process is devised in the economy of nature and hence brings the eruption to a close by relieving the strain due to accumulation. The gases have been allowed to expand, the froth and gas-charged liquid to escape and to cool.

(5) The cooling and congealing extends to a certain small depth below the crater and a term of repose ensues. Whatever the ultimate cause of the upward pushing force, be it gas pressure or the compressive stress of a shrinking globe, we know that the force is there. The lava has to escape once in so often, and the machinery of eruption adds so much new rock to the surface of the earth.

(6) A new term of accumulation in the deep region begins. There may be a few small earthquakes occasioned by the settling of the rocks over the void left by the lava flow, but in general, the years immediately following a complete eruption constitute a time of unusual quiet with little activity either seismic or volcanic. By complete eruption is meant the escape of the final lava flow for a given eruptive period, for some volcanoes have recurrent flows for several years before an eruption is finished.

MAUNA LOA 1914

Summarizing the six stages of a typical volcanic eruption, they may be briefly expressed as (1) earthquake stress, (2) gas foam explosion, (3) gas release, (4) liquid release, (5) solidification, and (6)

Inner pit made by subsidence of lava, January, 1915, within Halemaumau lava-pit, looking down from the north

new accumulation. Mauna Loa in 1914 illustrated the end of a period of accumulation (6), and a year of earthquake stress (1) initiating gas-lava foaming (2) in Mokuaweoweo, the summit crater, November 25, 1914, and gas release (3) took place through the summit orifices throughout December and January and probably continues at the present time (spring 1915) with subsidence for the time being of the lava froth.

That the approach to the solstice (December 22) and the earth's nearest approach to the sun (perihelion) about the same season induced effective stresses touching off the accumulated strain is probable. For in November, there were sixty local earthquakes, at the end of the month the summit fountains broke out and this activity endured until twenty days after the solstice, when the glow and fumes died away.

There remain yet to come in the present eruption of Mauna Loa stages 4, 5 and 6; namely, the escape of liquid lava, its solidification and the beginning of a new repose period. By this analysis, it should be plain that Mauna Loa is now active and must be so regarded until the lava flow comes.

It will now be profitable to review what the Hawaiian Volcano Observatory has done in preparing for and observing this eruption of Mauna Loa. The studies of men of science who have come to Hawaii from a distance, Dana, Friedlænder, Daly, Brun, Perret, Day and Shepherd, and the work of Brigham and Hitchcock, resident here, have thrown new light on sequences, intervals and the meaning of volcanic gases and these things are the basis of the deductions outlined in this lecture. Four of these workers have coöperated with the Observatory. The staff of the Observatory has made continuous records of the processes of Kilauea and has visited the summit crater of Mauna Loa at least once a year.

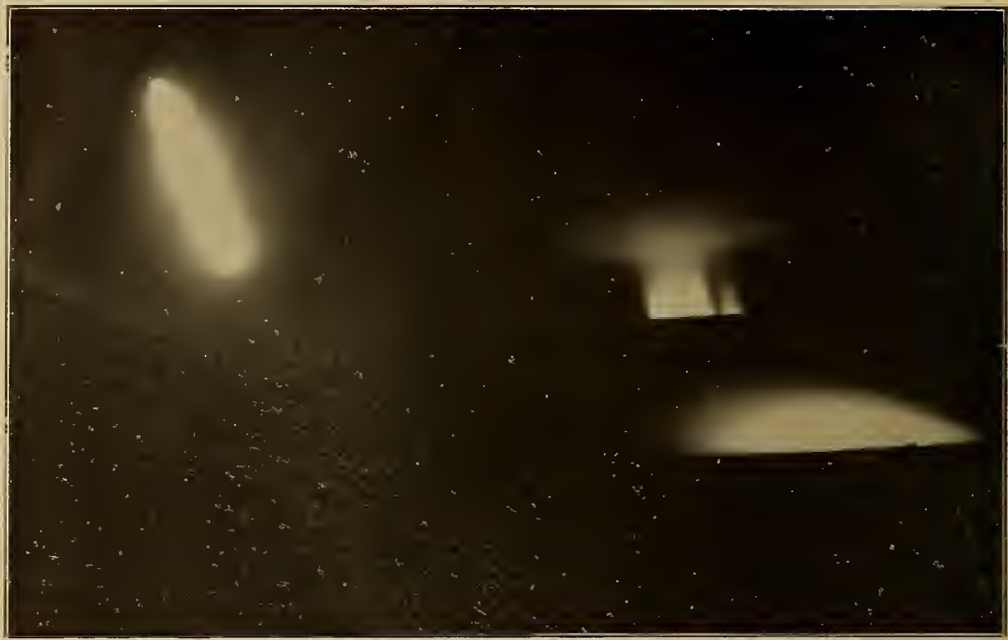
PREDICTION

From these records, I have worked out a tentative philosophy of the two volcanoes, as herein outlined, with a view to the practical service rendered the community in securing some basis of prediction, however inadequate and faulty our first attempts may be. Mr. H. O. Wood has been studying carefully the present day local earthquakes and the records of the terrific Hawaiian earthquake of 1868 and with me has been watching attentively the seismic and volcanic activities in their relation to the tidal and other stresses set up in the globe by the sun and moon. Mr. Wood has made a special study of the theoretical effects of the declination of the sun and moon north and south of the equator. From all these studies of records of the past, records of the present and of the processes of physics and astronomy, it became possible to foresee that Mauna Loa would have a summit outbreak between 1911 and 1915, that it was most likely to come near June or December, and this much has been verified in 1914. By similar reasoning, there remain the as yet unverified expectations (1) a very low level of the lava of Kilauea; (2) a lava flow from Mauna Loa, probably within four years and most probably in not less than three years; (3) the occurrence of a short-lived summit outbreak before the flow; (4) the time of this outbreak probably near June or December, this combination making January or July of 1918 likely times for the eruption to culminate; and lastly, (5) the lava flow should break out from a vent on the north side of the mountain, probably somewhere above the Dewey Crater of 1899. All this sounds like unwarrantably precise prediction, but the basis for it has been explained above. To such extent as such prediction proves useful and leads to proper preparation and precaution, it is justifiable.

In expectation of a coming eruption it was desirable for the Observatory to have a station on Mauna Loa occupied frequently for purposes of recording temperatures of fumaroles, local earthquakes, weather conditions and any other phenomena that might bear on the approaching outbreak. But it early became evident that this ideal could not be realized with the funds at the disposal of

The lava fountains of Mauna Loa from the east rim of summit crater, about one mile away. The main fountain, about 150 feet high, is under the white smoke, and appears against a dark half-dome of spatter of its own construction

the Research Association. Mauna Loa is a vast desert waste without water and rising to an immense height. Every expedition to the summit exhausts the energies of the men and animals employed, and the animals are frequently crippled and have their legs cut by the rough block lava. Consequently the ranchers will not rent good animals at any price and as there is no shelter on the summit, little water, no feed, violent winds and low temperatures, the men who can with difficulty be induced to go and act as guides or packers, object to remaining over night. The wages paid them and the hire of animals are high. All of this means that it costs several hundred dollars in order to take an unsatisfactory trip to the summit, see the crater, and return before any real scientific work can be done and even before the party is acclimated to the unusual altitude. In the winter time there is deep snow on the summit plateau and snow flurries or violent thunder storms with heavy gales of wind may occur at any season and make havoc in a camp of tents. There is no soil, so ordinary tent pegs cannot be used and there is no flat ground on which to sleep. There is no fuel of any sort and there are no hillocks or valleys to offer shelter. The crater Mokuaweoweo is surrounded by vertical precipices from three hundred to eight hundred feet high and the floor is accessible only by arduous climbing. The area of exploration for proper study of hot vents whence lava flows may issue, and of the seven or eight summit vents (pits and cones) including the great crater is fully twenty miles long by three wide, not including the separate area of flows in Kau to the



Kilauea, Mauna Loa and the Moon, November 25, 1914, midnight, first night of outbreak of Mauna Loa. From the east

Lava Whirlpool, interior of lava-pit, February, 1913, looking down from the east

south thirty miles away. It will be seen from this that Mauna Loa presents a problem of extensive exploration under difficult conditions and is not like Kilauea in possessing a single lava pit conveniently accessible.

The most that the Observatory has been able to do, therefore, in dealing with Mauna Loa during its repose, was to send an expedition to the summit once each year and to record the observations of other travelers whenever such were available. Observatory expeditions visited Mokuaweoweo in August 1912 and October 1913 and no unusual phenomena were noted, the only activity being very slight vaporing from cracks both in the bottom of Mokuaweoweo and in outlying fissures. These steaming fissures extend both northeast and south from the crater, the directions in which large rifts trend down the mountain along lines of historic lava vents.

COURSE OF PREMONITORY ERUPTION

In 1914 the Whitney Laboratory of Seismology in the basement of the Observatory, equipped with seismographs, registered groups of earthquakes from time to time in seismic spasms, and reports came from Kau and from the ranchers on Mauna Kea of sudden strong earthquakes in the line of the axis of Mauna Loa's greatest length. In November 1914 the registration of about sixty earthquakes in three weeks, the greatest number ever recorded in like time since the instruments were set up, greatly stimulated our attitude of expectancy. On November 25, 1914, about 12.45 p.m. the instruments showed prolonged earthquake movements of an unusual character, and at the same time cattle herders on Kapapala Ranch saw thick fume clouds puff up suddenly above the summit crater of Mauna Loa. After that the earthquake activity diminished.

The eruption became visible from the Observatory as darkness approached, November 25, and photographs were made of Mauna Loa from the vicinity that night and on succeeding days and nights. These photographs show the column of glowing fumes, the glow diminishing rapidly after the first night.

November 26 I started for the summit by way of Kona, being unable to get men or horses for the Kapapala trail in Kau. I reached the summit area in a blinding sleet storm November 28 and was unable to do any work on account of the storm. Fortunately two young men from Kau, Messrs. Forrest and Palmer, pushed their way to the summit on the previous night, November 27, and furnished the Observatory with a sketch map and notes. They saw ten or twelve fountains of lava along a north-south rift in the bottom of the crater, one of these in the southern part being between three hundred and four hundred feet high. December 2, Charles Ka was sent to the summit by the writer and saw only four fountains. Similar conditions were noted a few days later by Messrs. Baker and Bowdish and on December 15, an expedition from the Observatory reached the summit on the Kau side and saw only one large fountain about one hundred and fifty feet high and a few small ones. These were photographed, but conditions were too stormy to permit an extended stay on the summit.

Throughout December a watch was kept at the Observatory on the fume column over Mauna Loa. It was occasionally photographed and it persisted until January 10, 1915, showing a line of bluish fume by day and a dull glow over the mountain at night. After that date it disappeared, the fountains probably subsiding and the lava solidifying.

PREPARATION FOR FINAL CRISIS

The Observatory has a difficult and expensive task before it if it is to make adequate record of the spectacular closing stages of this eruptive period of Mauna Loa. We have learned a useful lesson of the futility of attempting a scientific siege of the crater fortress in winter-time without houses built in advance to shelter men and animals. Such houses ought to be built of stone both at the summit and on the north flank of the mountain near the probable site of the

North walls of Mokuaweoweo, the summit crater of Mauna Loa, December 15, 1914

expected flow. The escape of the liquid lava after the months of temporary repose which we are now living through, will begin with more fountains at the summit; and with a slight earthquake prelude to warn us and a shelter camp, we ought to be able to have photographers ready to make pictures of the fountains at their highest. A probable time for this outbreak is about December, 1917, when the summit will be cold and snowy, but it may come sooner. It is certain that nothing can be done of scientific value at such a season without a summit hut and a shelter for horses.

The next stage will be a lava flow from a lower vent, probably six or eight miles to the northeast of the summit crater. A secondary camp should be prepared in this neighborhood so that photographs and measurements may be made of the fountains which generally shoot to an enormous height when the flow breaks forth, and thereafter of the flow itself in following its course or courses down the slopes.

These camps and the survey of trails to them will cost at least three thousand dollars and to maintain them and explore the field in their vicinity will cost three thousand dollars more. The work of survey and construction should be provided for at once, without delay, but there is no possibility of the Observatory doing this with its present means. It has no means to do anything beyond the recording of the activity of Kilauea and is barely able to do this owing to steadily decreasing income from subscriptions since 1912.

Governor Pinkham has gone on record as favoring legislative aid for this work, for the protection of the community and for the advance of science. Whether the money be furnished by the legislature, business corporations, an educational

Three-driblet dome; floor of Kelauea crater

institution, wealthy individuals, Honolulu, Hilo, or the County of Hawaii, or by all of these in concert makes no difference in the result, but it makes a very great difference if no one will furnish it. I suppose there is no question in anybody's mind but that the work ought to be done in accordance with the appeal of the directors of the Hawaiian Volcano Research Association approved by the governor and by the Honolulu Chamber of Commerce. It should not be a very heavy burden to raise two thousand dollars per annum for three years—1915, 1916 and 1917—and to turn this over to the Hawaiian Volcano Research Association with instructions to devote the money to systematic preparation for a survey of the expected lava flow from Mauna Loa.

The most that can be expected from the writer as director of the Observatory is a statement of why this should be done, what should be done and its probable cost. This he has attempted in this article. Mauna Loa has mobilized its forces and declared a war zone. The problem of furnishing the sinews of war cannot be left to the scientific staff.

INORGANIC FODDER

Germany has abundant supplies of potatoes, beet-roots and turnips, materials holding carbohydrates. Albuminous fodder, however, was scarce and had to be largely imported. An invention recently made in Berlin, says the *Scientific American*, provides a nourishing yeast containing more than 50 per eent. of albumen, prepared from sugar and ammonium sulphate. The sugar is bound to an inorganic base; in order to supply the albumen, the sugar is "fertilized" with ammonia, potash and magnesia, in the form of their salts, after which some yeast is introduced and a strong air current applied. The yeast then absorbs the sugar and the "fertilizer," thus resulting in the formation of a highly albuminous yeast.

THE PRINCIPLES OF HOSPITAL EFFICIENCY

A DISCUSSION OF THE ELEMENTS TO BE CONSIDERED IN GIVING THE HIGHEST EFFECTIVENESS TO THE MOST IMPORTANT OF OUR PUBLIC INSTITUTIONS

BY RICHARD WATERMAN

The hospital of today occupies a very much broader field of work than did the hospital of a century ago. Its functions include not only the care of the sick, but also the prevention of disease, the scientific study of the causes and the treatment of disease, and the systematic education of doctors, nurses and the public. In order to perform these functions properly, the hospital has been obliged to erect an elaborate plant; to provide a great variety of expensive equipment; and to supplement the efforts of its unpaid scientific staff by employing a special staff of highly paid experts in both the scientific and the business departments.

A brief summary of the financial and operative statistics of the hospitals in the United States may serve to emphasize these statements. The *Modern Hospital* for September, 1913, says: "There are in the United States 6,665 institutions of record for the care of the sick, with a total capacity of more than 600,000 beds. By a modest estimate these huge figures represent a money investment in land, buildings and equipment of not less than $1,500,000,000, and an annual outlay for maintenance approaching $250,000,000.

"On the human side there are more than 100,000 trustees of hospitals and more than 65,000 physicians on hospital medical staffs. About 10,000,000 men and women contribute annually to the hospital funds and approximately 9,000,000 men, women and children are patients in the hospitals in the course of each year."

The fundamental idea in efficiency is the elimination of waste. A hospital is efficient if it thoroughly performs its functions—the care of the sick, the prevention of disease, the research work and the education of doctors, nurses and the public—with the least possible waste of labor, materials and money. There is an enormous amount of waste involved in the current methods of operating hospitals. The waste of money probably amounts to more than 20 per cent. of the $250,000,000 paid each year for current expenses; and there is in addition a waste of human labor and of opportunity that is incalculable.

We waste the time of our trustees when we fail to adopt a system of financial records and reports that will enable the superintendent of the hospital to present to the board at frequent intervals an intelligent statement of the work done and the unit cost of the work.

We waste the time of members of the medical staff when we fail to provide the facilities that will enable them to do their work properly. The most eminent specialists give their services to the hospital without charge; and when they are unable to do their work for lack of suitable equipment it is just as truly a waste of time and of opportunity as it would be if they were receiving a large professional fee.

We waste the time of our nurses when we require them to learn a dozen different ways of doing their work in the operating room or in the wards because we have not discovered the one best way of doing the work and adopted it as the standard method of procedure.

We waste a large amount of money when we provide for the construction and equipment of hospitals where they are not needed; and at the same time we throw away the opportunity to construct and equip new hospitals where they are needed.

We waste a large proportion of the first cost of construction and of the annual cost of maintenance of our hospitals when we fail to make ourselves familiar with the experience gained by others. For example, a large American city has recently completed the erection of a municipal hospital at a cost of nearly $6000 a bed. The best experts agree that this is twice as much as it should cost; and also that the arrangement of the buildings will make the annual cost of maintenance from 50 to 60 per cent. more than is necessary.

We waste a great deal of money when we buy useless equipment without investigation merely because it has been recommended by some prominent member of the staff; and when we duplicate expensive equipment many times over in neighboring hospitals and then allow it to lie idle the greater part of the time. No corporation that is organized for profit could afford to do this; nor can a hospital afford to do it.

We waste a considerable part of the money that is spent in the purchase of medical, surgical and household supplies. In every hospital about 60 per cent. of the cost of maintenance goes for supplies; and about 60 per cent. of these supplies could be bought to good advantage through a properly organized central purchasing bureau.

We waste at least half of the money that we spend to maintain beds for convalescent patients in a hospital for acute cases. It is well known that the per capita cost in a convalescent home is less than half the per capita cost in an acute hospital.

We waste a great deal of money by failing to devise and adopt a good system of serving food to the patients. In one large hospital that has a very high reputation, the food is handled seven times and reheated twice between the kitchen and the patient's bedside; and in one 24-bed ward the number of trays on which food is left untouched has been known to be as high as 33 per cent.

We waste a great deal of time and money in our dispensaries when we admit a large number of patients, who take a great deal of the time of the dispensary physicians for preliminary examinations at which a careful diagnosis of each case is made; and later when we fail to take the necessary steps to insure the return of these patients after their first visit. For example, one large dispensary shows in its report for 1914 that in a certain clinic 45 per cent. of the patients paid only one visit and adds that "not all of the work done for these patients was wasted, but most of it was."

We waste a large amount of money and human effort by failing to coördinate the various departments of the hospital; and by failing to establish recognized lines of authority so that we can direct the work of every person connected with the hospital along such lines that it will be of the greatest service.

An enterprise that spends $250,000,000 a year for current expenses is a large business undertaking and should be managed in accordance with sound business principles; and yet, it is true that very few trustees are prepared to apply the same principles in the management of a hospital that they apply, as a matter of course, in the management of their own business.

In these days of scientific management every progressive business man is studying the principles of efficiency. He knows that in his own business it pays to have a planning department that will help him to make sure that his staff is so organized, his buildings and equipment so arranged, and his financial and operative statistics so prepared that the work done will be as economical and as efficient as possible.

The business man should also realize that he can insure efficiency in the management of the hospital of which he is a trustee by precisely similar methods. A few hospital boards and hospital superintendents are already convinced on this point; but the great majority are still in doubt. This is largely due to the fact that there is at present no authoritative statement of the fundamental principles of hospital efficiency or of the general method of applying these principles.

In the absence of such a statement, it may be of service to present here a brief

outline of the principles of efficiency which are applicable in every field of human activity—business, professional, governmental, educational and philanthropic; and to show by a few concrete illustrations how these principles can be applied in the scientific departments of the hospital as well as in the business departments.

Mr. Harrington Emerson, one of the foremost efficiency engineers in the United States, has formulated the following list of the fundamental principles of efficiency: (1) Clearly defined ideals; (2) common sense; (3) competent counsel; (4) discipline; (5) the fair deal; (6) reliable, immediate and adequate records; (7) despatching; (8) standards and schedules; (9) standardized conditions; (10) standardized operations; (11) written standard practice instructions; and (12) efficiency reward. Each of these principles really is fundamental and should be given careful consideration by trustees who desire to make the management of their hospital efficient.

The ideals for which the hospital is working should be clearly defined. A few years ago the hospital confined its attention to the treatment and care of people who were already sick. Today, in addition to caring for the sick it devotes a great deal of attention to keeping people well. A few years ago the average hospital made no effort to follow discharged patients into their homes in order to measure the results of hospital treatment. Today in many of our best hospitals the follow-on system is an important part of the work. A few years ago, no systematic effort was made to add to the medical diagnosis and medical treatment a social diagnosis and systematic treatment by a trained social worker. Today, there are hospitals and dispensaries where the social worker is as much a part of the clinic as is the doctor or the nurse.

The hospital should use a reasonable amount of common sense. For example, it should avoid the unnecessary purchase of costly apparatus. At the present time it frequently happens that the expensive equipment needed to facilitate diagnosis and treatment is duplicated many times over by neighboring institutions. This results in extravagant expenditures and a great deal of preventable waste.

The hospital should seek expert advice when necessary. It is not possible for each of the 6,700 hospitals in this country to include as permanent members of its staff all of the specialists whose advice will be needed at one time or another. Each must, therefore, be prepared to employ competent counsel when needed—a hospital consultant to help in planning new buildings; an expert accountant to devise and install a system of financial records and reports; an efficiency engineer to discover and eliminate every form of preventable waste, etc.

The hospital should enforce discipline in all parts of its organization. Rules governing the treatment and care of the patients and the general conduct of the hospital should be clearly defined by the board of managers and placed in the hands of each member of the administrative, the medical and the nursing staff; and these rules should be enforced.

The hospital should give a fair deal to its patients and to the public as well as to its contributors, its managers and its staff of doctors and nurses. The fair deal requires that the interests of the patient treated in the hospital or in the dispensary shall be protected by making sure that in each case the physician or the surgeon in charge is really competent to do the professional work involved. The fair deal requires that the interests of the contributor who is asked to support the hospital shall be protected by giving him some assurance that the money he contributes will be used to good advantage. The fair deal requires that the interests of the doctor who contributes his services shall be protected by giving him as far as possible the facilities he needs in order to perform successfully his part of the hospital work.

The hospital should keep reliable, immediate, adequate and permanent records. The system of medical records should be such that it will aid the staff, not only in their treatment of the patients but also in preserving the history of each case in such a form that it will be available for use in the future as a record of ex-

perience and as an aid to teaching. The system of financial records and statistics should be such that it will enable the hospital executive to lay before the board of managers at frequent intervals a clear picture of the work done and the unit cost of this work; and will afford a common basis for the comparison of each hospital with every similar institution throughout the country.

The despatching of patients in a hospital should be just as prompt and systematic as the despatching of trains on a railroad. A patient who applies for admission to the hospital should be examined promptly by the admitting officer; assigned at once to the proper room or ward, and seen within a reasonable period by the visiting physician or surgeon on service; and instructions given by the visiting physician in regard to treatment and care should be carried out promptly and thoroughly by the resident members of the medical and nursing staff.

The hospital should establish definite standards by which to measure the economy and the efficiency of its work. One institution may have a per capita cost of $3.00 per day and another may boast of a per capita cost of $1.10 per day. It is necessary to establish some definite standard by which to measure the per capita cost before we can determine whether it is a credit or a disgrace to have a per capita cost of $1.10. One dispensary physician may treat twice as many patients in an afternoon as his colleague who is working under similar conditions. It will be necessary to know that he treats them with equal success before we can say that he is twice as efficient as his colleague.

The hospital should standardize the conditions under which its work is done, *i. e.*, it should make a scientific study of the results of experience in many hospitals in order to determine the conditions under which each class of patients can be cared for with the highest degree of success; and should then provide in each department the facilities indicated by the results of this study. For example, the principal service rooms should usually be located as close to the wards as possible. In one hospital these rooms are so close to the wards that the number of steps the nurses take in order to do their daily work is reduced to a minimum. In another hospital, the nurses are required to go to the other end of a long corridor every time they need to use the diet kitchen, the sink room or the duty room.

The hospital should standardize its plan of operation. A few years ago in one of the leading hospitals of this country, which has been used as a model by many other institutions, there were 33 members of the staff who had authority to admit patients. In the same institution today there are only two members of the staff who have this authority—an admitting officer and his assistant. In some hospitals the medical records for each service and for each dispensary clinic are kept in a different place and are not cross-indexed. In a few of the more modern institutions the hospital, dispensary and social service records are all consolidated, and it is possible to find in one place a continuous medical history of each patient from the time that he was first admitted to any department of the hospital.

The hospital should define clearly the rules and regulations governing the ordinary procedure for every department so that even when there are frequent changes in the personnel of the medical staff, the nursing staff or the administrative staff, the policy and the practice of the hospital will be continuous.

The hospital should give a suitable reward for efficiency in every department of its work. In the business departments, for example, the amount of compensation paid to employees should be determined by applying the same standards that would be applied in any well-managed commercial enterprise. In the scientific departments the professional recognition given to a member of the staff should be, as far as possible, directly proportional to his professional success. In many hospitals this principle is not recognized and promotion is made to depend not on efficiency, but on seniority of service.

Many different plans have been proposed with a view to increasing the effi-

ciency of hospitals in the United States—either individually or collectively. The American Medical Association has established a hospital section and has appointed a Committee on the Standardization of Hospitals. The Clinical Congress of Surgeons of America has appointed a similar committee, which submitted a report in November, 1913, making certain definite recommendations. The American Hospital Association has urged for years that a comprehensive study be made and that plans be developed for the classification and standardization of all of the hospitals in the United States; and at each of its annual meetings has appointed standing and special committees to report on various phases of hospital efficiency. All three of these organizations have urged the Carnegie Foundation to prepare a report on the classification and standardization of hospitals—a report that would perform as great a service for the hospitals of this country as the report on "Medical Education in the United States" has already performed for the medical schools.

The committees of these various organizations are now trying to formulate a satisfactory plan for accomplishing the purpose for which they were appointed. They realize that they must propose a plan that will not be objectionable to the hospitals; and one that it would be possible for some properly constituted agency to carry out, provided it is willing to undertake the work and assume the necessary expense.

It is not possible to make an individual study of each of the 6,700 hospitals in the United States and present the results in comparative tables. It is not possible to grade the hospitals saying—"this hospital is in Class A" and "that hospital is in Class B" nor is it desirable to do so. It is not possible to set up an arbitrary standard which every hospital must attain if it is to be regarded as a reputable institution. And yet these are some of the suggestions that have been urged as essential parts of any proposal looking towards the classification and standardization of hospitals.

It is possible to define the terms "classification" and "standardization" in such a way that under the definition both the classification and the standardization of hospitals in the United States can be accomplished, if sufficient resources are provided for the purpose.

For example, the American Hospital Association or the Carnegie Foundation or some other properly constituted authority might undertake—

(a) To prepare a schedule for the classification of hospitals providing for a number of different groups, each of which would include those institutions which are sufficiently similar to be comparable.

(b) To make a study of a few typical institutions in each group included in the proposed classification, and in addition of all of the teaching hospitals in the country; but to make no attempt to grade each hospital or to measure its efficiency as compared with other institutions.

(c) To define standards by which to measure efficiency in each of the proposed groups so as to make it possible for the managers of any hospital to apply the standards themselves and to measure the efficiency of their own institution.

(d) To include in the report a study of the work done by hospitals for the education of doctors, nurses and the public.

The suggested plan makes provision for defining standards by which to measure the efficiency of a hospital—standards that will help the trustees of any hospital in the country to answer the following questions in regard to their own institution:

(a) Is the organization of our hospital efficient?

(b) Is the management scientific?

(c) Are the buildings so planned that the hospital can avoid preventable waste?

(d) Is the equipment such that it is possible for the hospital to do the best work?

(e) Does the hospital spend a sufficient amount of money each year to insure good work?

(f) Are the medical and financial records kept in a form that will enable the trustees to measure the amount and quality of the work done and the unit cost of the work?

(g) Do the social service and follow-on systems enable the medical staff to ascertain the end results of their work?

(h) Are the physicians and surgeons getting as good results as they should in the treatment of their patients?

(i) Does the hospital coöperate actively with the public authorities and with various private institutions and agencies to protect the health of the community?

The proposed study of hospitals should result in establishing under the auspices of the American Hospital Association, a Central Hospital Bureau that—

(a) Will place within the reach of every hospital in the United States the latest information in regard to hospital organization, management, construction and equipment.

(b) Will make the necessary tests and establish standards of quality and price for the medical, surgical and household supplies ordinarily used in our hospitals; and will thus help every hospital—large or small—to save the money now wasted in purchasing supplies without a full knowledge of current market conditions. This would result in a very substantial saving since the present annual cost of the supplies used in American hospitals is about $150,000,000.

(c) Will help to develop a community program for hospital work with a view to preventing the unnecessary duplication of expensive equipment and the overlapping of work that have proved so wasteful under the present system.

(d) Acting in an advisory capacity will aid individual hospitals in their efforts to increase their own efficiency and to make the best use of the funds entrusted to their care.

The proposed Central Hospital Bureau, with its skilled organization, its complete hospital information, its modern systems of investigation and record, its staff of hospital consultants, expert accountants and auditors—all at the service of each hospital—will make it possible for the smallest institution to be conducted with the same precision and skill as the largest and for all of them to effect a great saving in their expenditure of time, money and human effort.

A report developed along the lines suggested would be of great service to the hospitals, the medical schools, the nursing profession and the public.

It would be of service to the hospitals because it would enable each institution to measure its own efficiency and would present constructive plans for increasing the efficiency of those institutions which do not measure up to the standard.

It would be of service to the medical schools since it would help them to develop more effectively that side of their work which must be done in a teaching hospital.

It would be of service to the nursing profession since it would define standards for the training schools for nurses and show them what is generally recognized as the proper course of study, the necessary equipment and the desirable facilities for a training school for nurses. This part of the report would have a very wide application since a majority of the hospitals in the country have training schools for nurses. Many of them are sending out each year large classes of young women who are allowed to become graduate nurses and to enjoy all of the privileges of the profession, without having received an adequate training for the work.

It would be of service to the public since it would make clear the necessity for including in the organization of every hospital some provision for protecting the interests of the patients. It is an acknowledged fact that some of the best medical work and some of the worst is done in hospitals, and it is very desirable that some steps should be taken to enable the public to determine which hospitals are entitled to their confidence.

The proposed schedule for the classification of hospitals would provide for a number of different groups. It is obviously unfair to compare a large general hospital in New York with a 30-bed hospital in some small interior town; or a contagious disease hospital with a hospital for incurables, or an insane hospital with a children's hospital; but it is quite possible to group these institutions in such a way that those which are grouped together can be compared.

The proposed study of hospitals should result in a report that will present the essential facts—

(a) In regard to the number of hospitals in the United States, the number of patients treated, the number of managers, doctors and nurses actively engaged in the work, the amount of money invested, the amount of money expended each year for maintenance and other data that can readily be obtained from recognized sources of information.

(b) In regard to each of the teaching hospitals in the United States showing what it does for the education of medical students, for the further education of members of the medical profession, and for the movement to add to the available knowledge of the causes, the prevention, the diagnosis and the treatment of disease.

(c) In regard to the educational work done by hospitals where nurses are taught in the training school for nurses, in various departments of the hospital, and in various dispensary clinics; and where the public is taught by hospital and dispensary physicians, by lecturers and teachers in the out-patient department, by social service workers and by the publication of suitable material in the form of annual reports, special publications, and articles in the periodical and daily press.

(d) In regard to a few typical hospitals in each group included in the proposed classification.

HOW THE TELEPHONE DIAPHRAGM WORKS

The Electrical Research Laboratory of the Massachusetts Institute of Technology has been engaged the past year on a number of technical researches, and a report of Professor Arthur E. Kennelly of Cambridge, chairman of the laboratory, to President Maclaurin, sets forth a number of these interesting investigations.

An important point here is the fact that Technology has an electrical laboratory, the efforts of which can be devoted to scientific research as distinguished from commercial work and it is further a sign of the times that business men see advantages in the support of such a laboratory and assure its support to the extent of twenty to twenty-five thousand dollars a year.

One of the subjects on which Professor Kennelly recently reported to President Maclaurin is the behavior of metallic discs such as are used in telephones. It was desired to establish what the mechanical movements of the parts of such a disc might be with a view to establishing standard formulas for them. A research undertaken by Dr. H. O. Taylor of Cambridge, relates to the analysis of sound waves and a number of devices were tried in the hope of recording the passage of the wave in air. The attempts were in vain so that it was decided to investigate quantitatively the behavior of the metal diaphragm. With the exception of a very limited area in the centre of such a diaphragm, the field had been practically untouched.

The apparatus is comparatively simple, a metal plate such as is in use in telephones, a round frame in which to clamp it tightly about the edge and a triangular mirror supported from a bridge. The immediate purpose was to measure the motion of the metal disc. The point of the mirror was applied directly to the place which it was desired to measure; the mirror took up the motion of the disc and by means of a beam of light reflected from the mirror the nature and amplitude of the movement could easily be determined.

The flexibility of the apparatus was such that the motion of any point in the diaphragm could be measured in direction and amplitude and for glass discs as well as metal, the movement being actuated by a range of sounds from an organ pipe which corresponded in pitches to the limits under which the telephone must work.

There exist already some fundamental formulas of Bessel lately set forth by Lord Rayleigh and the correspondence of actuality to hypothesis has been shown by the Technology experiments. It has further been shown that within the limits of the experimental conditions the vibration decreases regularly from centre to edge and the plate does not break up into sections such as those shown by the Chladni sand figures.

HARDENED OILS

A MEANS of permanently changing an oil into a solid fat has been sought after by the oil chemists with almost the same zeal that the quest of the philosopher's stone was pursued by the alchemists. Nor did the fact that the product is only doubled in value, instead of being increased sixteenfold or more, diminish their ardor.

The problem was one similar to the preparation of sugar $C_{12}H_{22}O_{11}$ from starch $C_{12}H_{20}O_{10}$ (2 mols), here involving the simple addition of a molecule of water; in the case of the oils it was even simpler—the addition of three molecules of hydrogen,* a mere trifle of a tenth of an ounce or a little more than a cubic foot to the pound, being sufficient.

The procedures followed, by reduction of "red oil" with hydriodic acid, by chlorination and subsequent reduction with zinc, by reduction with nascent hydrogen, by treatment with electricity in an atmosphere of hydrogen, were all either too expensive or gave indifferent yields.

In a memoir published in the *Annales de Chimie* in 1905, Sabatier and Senderens called attention to the fact that hydrogen could be added to unsaturated bodies by the use of certain finely divided metals, which so far as could be ascertained played no chemical part in the reaction—catalysts—as they are called. A temperature of 300° C., with or without pressure, was necessary and nickel, cobalt iron, and copper were the catalysts employed.

As carried out at the present time, the process consists in causing the oil to circulate through grids supporting the catalyst, usually nickel or palladium, at a temperature of about 180–250° C., and under a pressure of ninety pounds of hydrogen. The melting point of the fatty acids ("Titer" or "Titer Test") is raised, and the operation can be interrupted at any point to give a fat of the desired consistency. As a result any oil, cottonseed, linseed, whale or fish, garbage grease, whether ancient or recent, sweet or strong-smelling, can be transformed into soap or candle stock of any desired hardness. The process does even more than this, it changes the before-mentioned oils—an ancient fish oil for example—into edible fats: the product is bacteria-free and physiologically uninjurious. So successful has the process become, that it is proposed to limit by law the production of edible fats and oils from loathsome sources; for example, garbage grease, cadaver and by-product fats. While it might be easy to pass this law, its enforcement would be extremely difficult, as the recognition of the different fats and oils now is well-nigh impossible; the difficulty of recognizing them after having gone through this process would probably be unsurmountable.

Products obtained by this method can probably be recognized by the fact that they contain small quantities of the catalyst used—nickel for example.

The question has arisen as to the physiological effect of small doses of this metal; it has been found that foods cooked in nickel or nickel-plated ware contain more nickel than the hardened fats, and furthermore that 99.8 per cent. of the metal is rapidly excreted from the system.

They are employed as soap stock—a fish oil which it would have been utterly out of the question to use, on account of the odor and consistency of the product, now gives a soap which has a "finer, cleaner and whiter look than that made without it." The slight odor can be masked by perfume. A disadvantage of the use of these fats is that the soap is so hard that it lathers poorly.

They find wide use as edible fats.

It is claimed for them that they can be heated hotter (to 455° F.) without smoking than ordinary fat: this cooks the outside of the food more quickly and prevents the grease from soaking in. Consequently it is less greasy, more digestible, dry and crisp. Another advantage is that no

$$* \ \underset{\text{lard oil}}{C_3H_5\begin{matrix}COO\,C_{17}H_{33}\\COO\,C_{17}H_{33}\\COO\,C_{17}H_{33}\end{matrix}} + 3H_2 = \underset{\text{tallow}}{C_3H_5\begin{matrix}COO\,C_{17}H_{35}\\COO\,C_{17}H_{35}\\COO\,C_{17}H_{35}\end{matrix}}$$

odor is absorbed; fish, onions and potatoes can be cooked successively in the same fat. Another claim is that one fourth less is used of these fats than of butter; further that it is all fat, while butter contains 5 to 16 per cent. of water.

Finally hydrogenated vegetable oils seem to offer a satisfactory substitute for animal fats to those who object to the latter from prejudice or religious scruples.

A. H. Gill.

RECONSTRUCTED CREAM

Because of many unfortunate experiences the public is naturally prejudiced against any alterations of food products, yet in some cases, such as cream, the result is beneficial rather than detrimental. In some parts of the South there are no dairy farms, and the table would be without cream were it not for a process of reconstruction. Desiccated milk is mixed with water and with butter from which the salt has been carefully washed out. The mixture is now forced through a machine called a homogenizer. By this process the butter fat is put back into the milk and delicious cream is thus obtained which cannot be distinguished in taste from the natural product.

Ice-cream makers employ a similar method in order to provide against inequalities of demand. On hot evenings there is a rush toward the ice-cream parlors, and to meet the greatly increased consumption the dealers draw on a supply of heavy cream which they have kept in a frozen condition. This frozen cream is thawed out, mixed with a proper proportion of milk, and put through the homogenizer. The homogenized mixture makes a smoother ice-cream than the natural light cream because, when the latter is frozen, much larger ice crystals are formed, which can be felt with the tongue.

E. B. S.

INOCULATING TREES

The *Chemiker Zeitung* of recent date describes a method of destroying plant and household pests and fungi. Mercury is the material employed. In enclosed places it is used in the form of a vapor, but when trees are infected by insects, auger holes are bored in the lower branches in an oblique direction passing through the pith of the tree. These holes are filled with mercury, after which they are made air-tight with tree-wax. From two to seven grams of mercury are required for inoculation. This treatment is said to be not only effective for the purpose intended, but in most cases apparently assists in the growth of the plant or tree. The influence of the treatment continues for a year or sometimes more.

SCIENCE CONSPECTUS

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NATIONAL PARKS IN THE CANADIAN CORDILLERA

PHYSICAL FEATURES AND SOME OF THE MANY ATTRACTIONS IN THE CANADIAN NATIONAL PLAYGROUNDS SITUATED IN THE WESTERN MOUNTAINS

BY JOHN A. ALLAN

THE Canadian national pleasure grounds are becoming better known and more attractive each year to the citizens of the fair Dominion, and also to travelers from the United States and from abroad. Parks and pleasure resorts attract many tourists. All human beings have a peculiar strong instinct which craves for recreation. The number of nature lovers, pleasure seekers who visit the mountainous playgrounds of Canada, is annually increasing.

The scenery which a country contains that can be made readily accessible to the traveling public, and the pleasure opportunities which can be offered to the tourist can be ranked as one of the important natural resources of that country.

Statistics for 1913 show that the value of tourist traffic holds fourth place with respect to the revenue from Canada's national resources. According to the Canadian Travel Association, the amount of money spent by tourists in Canada in 1913 amounted to $50,000,000. The annual revenue of Switzerland from tourist traffic is about $150,000,000.

Mr. J. B. Harkin, commissioner of Dominion parks, in his annual report for 1914 says: "The slogan which Canada's outstanding advantages in the way of natural scenic and other attractions justify using in regard to parks' development in Canada is 'See America's Best.'" The slogan which has been previously adopted on the continent is "See America First."

Canada set aside her first mountain reserve for the benefit and pleasure of the people in 1887. Today there are eight national playgrounds in the Canadian Cordillera between the Great Plains and the Pacific Ocean. Rocky Mountains Park, Yoho, Glacier and Revelstroke Parks are situated on the main line of the Canadian Pacific Railway; Jasper Park and Mt. Robson reserve are along the Grand Trunk Pacific Railway; Waterton Lakes Park lies south of the Crows Nest line; and Strathcona Park is situated towards the centre of Vancouver Island.

Three of these parks are in Alberta, the remaining five are in British Columbia.

Rocky Mountains, Yoho, Jasper, Mt. Robson and Waterton Lakes Parks lie within the Rocky Mountain system of the Cordillera; whereas Glacier Park is in the Selkirks and Revelstroke Park is along the edges of the Selkirk and Columbia ranges.

From a scenic point of view these parks are all different and yet all attractive in various respects. Each of these pleasure grounds will be briefly mentioned.

THE ROCKY MOUNTAINS PARK[1]

The Rocky Mountains Park of Canada is the largest and oldest of the Dominion national playgrounds. By an Act of Parliament in 1887 an area comprising 260 square miles was "reserved and set apart as a public park and pleasure ground for the benefit, advantage and enjoyment of the people of Canada." In 1902 this reservation was enlarged to include 4,900 square miles, but as this was found to be too large an area to preserve properly, the boundaries were reduced in 1911 to enclose 1,800 square miles, which is the present size of this world-known playground.

This reservation is situated about latitude 51 degrees, on the main line of the Canadian Pacific Railway west of Calgary. It lies entirely on the east slope of the Rocky Mountain system in the Province of Alberta and extends from the western edge of the plains westwards to the summit of the Rocky Mountains, which is also the continental watershed.

This park includes the entire drainage basin of the Bow River within the Rocky Mountains and has roughly the form of an isosceles triangle with the base running in a northeast and southwest direction. The Bow River may be taken as the perpendicular, as it enters at the apex and leaves the reservation about the centre of the base of this triangular area. The gateway to the park from the plains is also a natural portal to the mountains and is known as the Gap.

This reservation is commonly known as "Banff Park" since it includes the town of Banff, one of the best known and most popular mountain tourist resorts in North America.

Banff and Lake Louise, both well known resorts in the Canadian Rockies, are the only two distributing centres for tourists within this park.

The Rocky Mountains Park contains many features that would attract the general public, the nature lover, the artist or the scientist. It embraces the most rugged, picturesque and majestic part of the Canadian Rockies; many lakes with superb, artistic setting, the sulphur-hotsprings at Banff, and above all a museum of scenic beauty so extensive and so varied that it equals any in the world. The contrast of forested lower slopes, rock-barren, towering escarpments and pinnacles, capped with snow and ice, and lakes large and small nestling in a forest or in a rock face, offer variety and enchantment to the visitor. The scenery of this park never becomes old or monotonous, as there are still many new and unexplored and even unvisited valleys and notches. The topography of the park is rugged and distinctly Alpine in character. The lowest valleys reach down to 4,200 feet above sea-level, while the highest peak is 11,870 feet, seen in the Matterhorn of the Canadian Rockies—Mt. Assiniboine.

Physiographically there are three very distinct structural features to be observed within this park. The first of these is the sharp line of demarcation between the low, rounded ridge of the inner foothills, and the gray massive limestone mountains, void of vegetation and lightened by patches of snow manteling the upper slopes of the massifs. This break between these two physically different units is marked by an almost perpendicular escarpment, 2,500 to 3,000 feet high. So sharp is this break that it is possible to walk along the extreme eastern base of the Rocky Mountains. This feature is particularly noticeable between latitudes 49 and 52 degrees. This escarpment marks the front of an overthrust block which when the mountains were uplifted was thrust in places several miles over the plains to the east. At the base of the escarpment is exposed the overthrust fault which farther south is called the "Lewis Thrust." Within the eastern edge of the park along this fault the Cambrian beds are thrust over the lower Cretaceous formations.

The other two structural features of note within the park are to be found in the mountains themselves; two thirds of the eastern slope of the Rocky Mountains consist of a series of sharply defined ridges all parallel to one another which present a steep escarpment on their eastern face

[1] Published by permission of the Geological Survey Ottawa.

PLATE I. Mount Assiniboine (11,870 feet), the "Matterhorn of the Canadian Rockies," in the Rocky Mountains Park. Scenery typical of the range forming the continental watershed in the Canadian Rockies.

and a more gentle slope towards the west. These ridges are hugh uptilted fault blocks of rock, the more westerly blocks having been thrust partly over the block in front of it. The rocks in these fault blocks range essentially from Devonian to Cretaceous in age. The mountains in the western one third of the park are much older and belong to the pre-Cambrian and Cambrian periods. These formations have been up-arched into a broad fold which define the backbone of the Rocky Mountains system, as well as the continental watershed. The rocks in this portion are for the most part lying nearly horizontal. There is a sharp break which is represented by a fault between the younger formations on the east and the older formations on the west. The rocks within this park are entirely of sedimentary origin.

Rock structure has a marked influence on the scenery in the park. The types of forms to be seen about Banff, which is situated in the younger portion of the mountains, is quite different from that at Lake Louise which is situated in the older rocks.

Banff and Lake Louise (Laggan) although only 34 miles apart are very different as to location and scenery. The former is situated in the second range of the Rocky Mountains, on the floor of the Bow valley at an elevation of 4,542 feet above sea-level. Banff is the headquarters of the park with enclosures containing all varieties of mountain animals including several buffalo. It also contains a museum, meteorological station, headquarters of the Royal North West mounted police and the only food distributing centre for the entire park.

From a scenic point of view Banff is quite different from Lake Louise. It has a quiet, restful scenery developed in westerly tilted huge monoliths of rock with prominent escarpments on the east. No glaciers can be seen and the slopes are forested almost to the summits.

Lake Louise is situated at an altitude of 5,670 feet above sea-level and 533 feet above the railway at Laggan. The scenic features are truly Alpine consisting of a valley closed at one end by a glacier, surrounded by rugged mountains of flat-lying quartzites, limestones and shales,

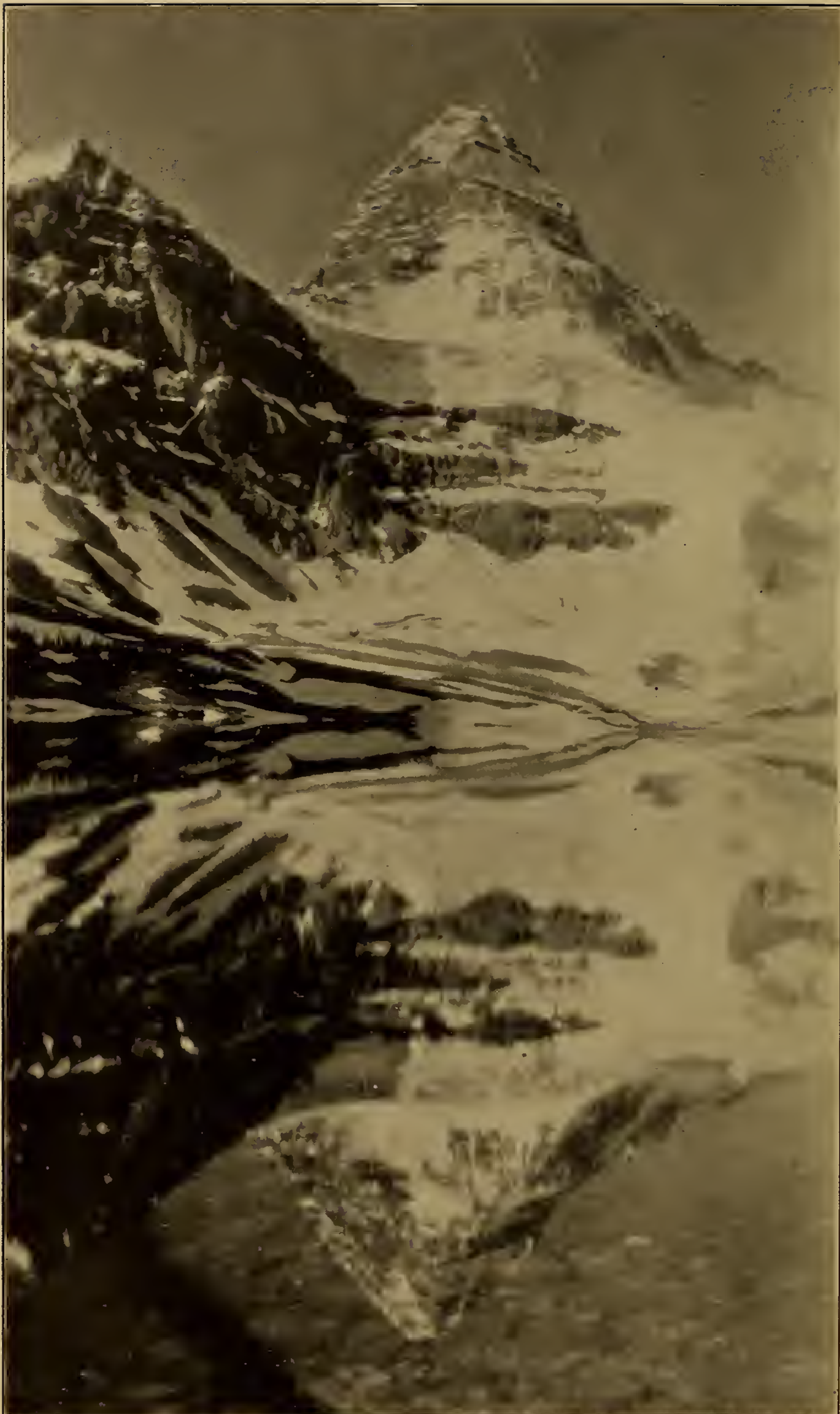


PLATE II. A perfect reflection of Mount Assiniboine in Lake Magog. Note the weird face-like form of some ferocious animal when viewed from the side.

whose summits average over 10,500 feet, and fringed with perpendicular cliffs or more gracefully curved slopes heavily timbered. The floor of the valley contains a lake of matchless beauty and the outlet of the valley hangs 600 feet above the floor of the Bow valley.

The highest and most prominent mountains are found on or close to the continental divide. The most lofty peaks include Mt. Assiniboine (11,870 feet); Mt. Temple (11,626); Mt. Hungabee (11,447); Mt. Victoria (11,355); Mt. Deltaform (11,225); Mt. Lefroy (11,220); Mt. Ball (10,825); Mt. Balfour (10,731); Mt. Fay (10,612); Mt. Aberdeen (10,340); Storm Mountain (10,309).

Among the many lakes of special individual scenic beauty that attract the tourist are Louise, Minnewanka, Vermilion, Bow, Hector, Spray, Shadow and Moraine Lake in the valley of the Ten Peaks.

This national playground can be visited easily and comfortably by all pleasure-seeking nature-lovers, whether in the railway coach, by carriage, by saddle pony or on foot. Within the limits of the park there are 300 miles of trails which are frequently traveled, and over 125 miles of carriage road. The government has taken steps to encourage trail travel by the erection of cabins at various points along certain trails. A telephone system is also being installed.

A motor road is being constructed from the plains to the coast. It is already completed through this park and crosses the continental divide at Vermillion Pass, fifteen miles west of Banff.

That the park is ever becoming more popular is witnessed by the yearly increase of guests shown in the hotel registers at Banff and Lake Louise. In 1914 over seventy-five thousand persons visited the park. Banff is also becoming a popular winter resort and offers facilities for all seasonable sports.

Year by year new places are being made more accessible to the tourist. The pleasure seekers will always find uncut pages in Nature's book to read. For magnitude, variety of scenery and accessibility, few places can surpass the Rocky Mountains Park.

YOHO PARK

Yoho Park, containing about 560 square miles, is situated on the western slope of the Rocky Mountains adjacent to the Rocky Mountains Park. The Kicking Horse River, rising on the continental watershed at the pass by the same name (locally called the Great Divide), divides the park almost through the centre. The grade of the upper part of the river is very steep; at one point, near the pass, in a distance of $2\frac{1}{2}$ miles there is a difference in elevation of 900 feet. The Canadian Pacific Railway follows close to this river. In order to overcome this steep descent it has been necessary to construct two spiral tunnels. The upper tunnel is in the base of Cathedral Mountain and is 3,200 feet long, while the lower tunnel, in Mt. Ogden, on the opposite side of the valley, is 2,910 feet long. The grade on the railway is 2.2 per cent.

Field, situated at the base of Mt. Stephen, is the tourist headquarter for the park and is a famous resort, equally as well known as Laggan and Banff.

From a scenic point of view few districts can surpass that in and about the Yoho Park. The topography is distinctly mountainous and Alpine in character, sculptured to a considerable degree by glacial action, whereas the valleys have been broadened and deepened by the effect of valley glaciers. Kicking Horse valley is a typical example of a V-shaped glacial transverse trough with steep walls and a broad floor.

Yoho valley, the largest tributary from the north, shows distinct evidence of the handiwork of the glaciers. Takakkaw Falls, nearly 1,200 feet high and Twin Falls, about 500 feet high, entering the Yoho from either side, rank among the most superb in the continent. Both are formed in massive middle Cambrian limestones and both come from typical hanging valleys enclosing glaciers. The Yoho glacier closes the northern end of the valley. The many peaks in the President range on the west and the Wapituk range on the east, present a panorama truly majestic. This valley can be visited in comfort by carriage. Another popular drive from Field is to Emerald Lake, a

Plate III. Mount Rundle at Banff, showing monoclinal structure with escarpment on the eastern face and gentle slope towards the west, typical of the eastern ranges of the Rocky Mountain system.

distance of seven miles along the famous snow-peak avenue. This drive passes the Natural Bridge where the water of the Kicking Horse River passes through a tunnel-like channel about four feet wide.

The park is well traversed by excellent trails along which the tourist is enabled to get a picturesque panorama for a radius of twenty-five to fifty miles.

Mention can only be made of such places of particular scenic interest to the tourist as the Ice River valley surrounded by such peaks as Mts. Goodsir (11,676), Vaux (10,881), and Chancellor (10,751); Ottertail valley; McArthur Pass and the Cataract valley with Lake McArthur, Lake O'Hara, Mt. Odaray (10,165), Cathedral Mountain (10,454), Mt. Biddle (10,876), Mts. Hungabee (11,447); Huber (11,041); Mt. Victoria (11,355), and many other peaks over 10,000 feet in the Bow range which forms the continental watershed. All of these mountains are readily accessible and can be climbed by the aspiring mountaineer. Mt. Stephen (10,485) one of the best known, can be easily climbed, and from its summit a magnificent panorama can be viewed. On the north slope of Mt. Stephen there is a small lead-zinc mine located 1,000 feet almost vertically above the railway.

Geologically this park is especially unique. Along the railway there is exposed one of the thickest Cambrian sections in the world. The total thickness of a continuous conformable series of quartzites, limestones and shales from the base to the top of the Cambrian was found to be over 18,500 feet.[1]

The rocks in the park are all sedimentary with the exception of a small area of igneous (plutonic) rock exposed in the Ice River valley. These rocks are alkaline in composition, ranging from nephelite and sodalite syenites, through ijolites and urtites to jacupirangites and other basic affinities. These rocks have been fully described by the writer in the memoir mentioned above. The mineral sodalite has a beautiful blue color and is much in demand by tourists as souvenirs.

GLACIER PARK

Glacier Park comprises an area of 468 square miles and is situated at the summit of the Selkirk range. This reservation is

[1]Allan, J. A., Geology of the Field Map Area — *Memoir 55*, Geological Survey of Canada, 1914.

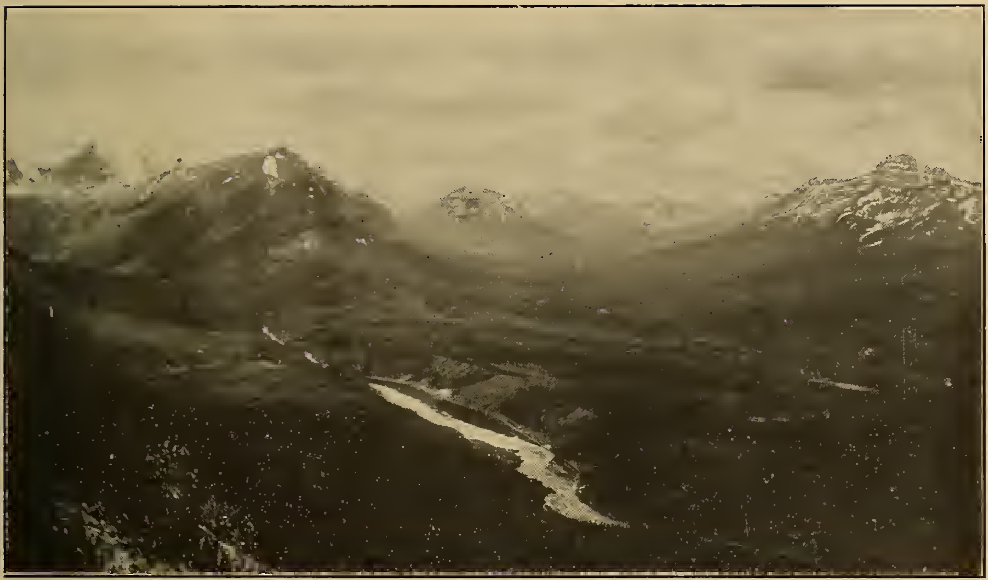


PLATE IV. Looking up the broad valley of the Bow River at Laggan, showing Mount Hector (11,125 feet), on the right, Hector Lake in the center, and Mount Daly (10,332 feet), on the left. The shape of this valley indicates its glacial origin.

the most westerly of the three situated on the main line of the Canadian Pacific Railway. Rogers Pass, the summit of the Selkirks, is located about the centre of the park. Glacier is the only distributing point for tourists in this playground and is situated on the south slope of the broadly rounded glacier-marked Illecillewæt valley.

The scenery in Glacier Park is equally grand as that of the Yoho in the Rocky Mountains Park, but it is nevertheless quite distinct. The mountain peaks are more numerous and more pointed in form than those in the Rocky Mountain system. This difference of form can be accounted for geologically. The rocks are essentially pre-Cambrian in age and consist of schists, slates, gneisses and other metamorphic types badly contorted and broken. This portion of the Selkirks represents the old terrane from which much of the sediment was derived which gave rise to the great thickness of Cambrian and other Paleozoic formations in the Rocky Mountains.

Two physical features are of special note, and should be visited by all tourists; the Illecillewæt and Asulkan glaciers, and the Nakimu caves. Both are reached by good trails. Within a few minutes' walk from the railway it is possible to stand on the frontal lobe of a real living and moving glacier. This gives one an opportunity to study glacial phenomena in the process of change.

The Nakimu caves (caves of Cheops) are situated in a cirque-like basin towards the head of Cougar creek on the west side of the Illecillewæt valley. These caves can be readily reached by a good trail from Glacier House, a distance of about seven miles, and are wonderful in their formation. They consist of a series of irregular subterranean channels which have been formed by running water from a crystalline limestone. There have been several miles of these tunnels explored and they furnish an interesting and somewhat eerie expedition to the visitor. A description and map of these caves has been published by the Parks Branch, "The Nakimu Caves, Glacier Dominion Park, B. C.," Dominion Parks Branch, Department of Interior, Ottawa, 1914.

A considerable portion of the park still awaits the explorer and adventurer.

Game is abundant, especially the grizzly and black bear, whereas the more open mountain slopes offer a museum of floral variety for the botanist.

JASPER PARK

Jasper Park, although still quite young, is year by year becoming better known. This reservation is situated on the Athabaska River west of Edmonton and is reached by the Grand Trunk Pacific Railway. The park comprises an area of 1,000 square miles, which includes a strip 20 miles on each side of the railway and extending from the foothills, west to the continental watershed on either side of Yellowhead Pass which also marks the western boundary of Alberta.

The position of Jasper Park in relation to the Rocky Mountains is quite similar to that of the Rocky Mountains Park 200 miles to the south, in that they both occupy the entire eastern slope of the mountain system from the plains to the continental divide.

The topography in Jasper Park, although by no means so rugged and precipitous as that in higher altitudes to the south, is nevertheless attractive, pleasing and varied in its character. The valley of the Athabaska is broadly rounded and well forested. The broadened river course forming Jasper and Brulè Lakes and the meandering braided character of the stream in places add beauty to the landscape when backed up by a forested slope terminating in a massive grey limestone escarpment, with well-nigh perpendicular walls. Roche Miette is a good example of this.

The town of Jasper is the headquarters of the park and is also the most central point of distribution. It is situated on a broad flat terrace on the north side of the Athabaska at a point where the Miette River coming from Yellowhead Pass joins the Athabaska. From this centre an excellent panorama can be observed of the lofty ranges at the head waters of the Athabaska River, which contain some of the highest peaks in the Canadian Rockies.

The topography of the ranges west of Jasper is quite distinct from that to the east. A line crossing the railway about two miles east of Jasper and drawn in a northwest-southeast direction divides the younger portion of the Rocky Mountains consisting largely of westerly tilted monoclinal fault blocks of Devonian to Cretaceous rocks, from the older portion represented by Cambrian and older rocks that make up the ranges which mark the continental watershed. This structural feature is similar to that more fully described under the Rocky Mountains Park.

Pyramid Lake, about three miles from Jasper, offers excellent facilities for boating, fishing and camping.

Although outside of the present limits of the park, Maligne Lake, situated in the valley by the same name, is a most picturesque spot surrounded by the Opal and Maligne ranges. It is becoming a popular camping spot for visitors to the park and can be comfortably visited by a good trail from Jasper.

Another physical feature that is making the park well known is the presence of sulphurous hot springs (Miette hot springs) situated towards the eastern end of the park about seven miles from the railway in the valley of Fiddle creek. There are several of these springs and the temperature varies to a maximum of 127 degrees Fahrenheit. The water in some of these springs has been proved to have certain medicinal properties for rheumatics.

MOUNT ROBSON RESERVE

Mt. Robson Park reservation is under the control of the Province of British Columbia; it therefore is not a Dominion park. It will however be briefly mentioned here as a national pleasure-ground.

This reservation joins Jasper Park on the west and includes the ranges to the northwest of Yellowhead Pass, forming the continental watershed. This park is still comparatively young and has not yet been thoroughly explored. It however contains some of the most majestic and rugged scenery in the continent. Mt. Robson, "the Monarch of the Canadian Rockies," has an altitude of about 13,700 feet above sea-level. It is the most lofty peak in the Canadian Cordillera south of the Yukon. There are a number of other peaks in the Robson group equally

PLATE V. Mount Stephen (10,485 feet), with the town of Field in the foreground. (Yoho Park.)

as magnificent, but much lower in elevation. Associated with these summits are many square miles of glaciers and snowfields that add beauty to the panorama.

The Robson district is reached by a good trail from Mt. Robson station on the Grand Trunk Pacific Railway. Berg Lake and Lake Kinney are two beautiful large sheets of water at the base of Mt. Robson; they are connected by the Valley of a Thousand Falls. In the Fraser valley, along which the Grand Trunk Pacific and Canadian Northern Railways follow, Yellowhead Lake near the pass by the same name, and Moose Lake farther west offer facilities for boating and fishing; these also add charm to the surrounding scenery.

The rocks in this district are chiefly pre-Cambrian and Cambrian in age and are all of sedimentary origin.

A description of this district is given in the *Canadian Alpine Journal*, Volume IV, 1912.

WATERTON LAKES PARK

Previous to 1914, this was the smallest Dominion mountain reservation, having an area of 16 square miles. It has since been enlarged to include 432 square miles.

This park is situated in the extreme southwestern corner of the Province of Alberta. It is bounded on the west by the continental watershed, on the east, for the most part, by the eastern face of the Rocky Mountains, on the north by Township Five and on the south by the International boundary line.

Waterton Lakes Park adjoins the United States Glacier National Park which has been described in *Bulletin* No. 600 of the United States Geological Survey.

Although this reservation has not yet become well known on account of the lack of roads and trails, yet it is bound to become a popular resort especially for the citizens in Southern Alberta. One of the principal features at present in the park is the chain of lakes after which the park has been named. The upper Waterton Lake extends for about three miles south of the International boundary.

This chain of lakes is walled in by steep promontories and rock escarpments which rise to an elevation of 8,000 feet. The lower lake lies just outside of the mountains and is separated from the middle and upper lake by a broad delta of alluvial material carried down by Blakiston

PLATE VI. Twin Falls, in Yoho Valley, Yoho Park.

PLATE VII. Typical Yoho Park scenery. Mount Stephen on the right and Cathedral Mountain on the left, taken from Burgess Pass.

creek (Pass creek). The lakes within the mountains are entirely of glacial origin. There are other equally picturesque lakes within the park; of these Summit Lake (Oil Lake) lies in a large cirque close to the continental divide and extends across the boundary line into the United States. This lake is drained by Oil creek, so called because small quantities of crude petroleum have been obtained in three or four drill holes in this valley.

The scenery within the park is typical of the eastern part of the Rocky Mountains. The ridges making up the Lewis-Clark ranges usually have a steep escarpment on the eastern face and a more gentle slope to the west.

There are no true glaciers, but large patches of perennial snow may be seen on many of the higher slopes. Very little is yet known of the northern half of the park. There is a wagon road from the plains, up Blakiston (Pass) creek and over the continental watershed at South Kootenay Pass at an elevation of 7,100 feet. This road continues down the west slope of the Rocky Mountains into the Flathead valley.

Fish abound in the lakes and game of various kinds is to be found in almost any valley.

REVELSTROKE PARK

Revelstroke Park is the youngest and smallest of the Canadian Cordilleran playgrounds. It was set aside in June 1914 and consists of 48 square miles in the vicinity of the town of Revelstroke on the main line of the Canadian Pacific Railway. It is located on the extreme western flank of the Selkirk range on the eastern side of the Columbia River.

The park is being opened up rapidly by the construction of trails and a motor road to the top of Mt. Revelstroke. This peak is only 6,500 feet high, yet from its summit there is a magnificent panorama towards the Selkirks, the Gold ranges, the Cariboo district and up the Columbia valley. An endeavor is being made to make this park a popular winter resort.

PLATE VIII. Mount Robson (13,700 feet, the "Monarch of the Canadian Rockies"), and the gateway to the many glaciers and lakes in the Mount Robson reserve.

STRATHCONA PARK

In June, 1910, the government set aside an area comprising approximately 260 square miles to be used as a reservation and playground in the centre of Vancouver Island. This area was called Strathcona Park. Since the original limits of the park did not include much of the finest lake and mountain scenery, the government in 1913 extended the limits of this reservation to include about 800 square miles.

Strathcona Park is situated about the centre of Vancouver Island; the northern gateway is about 120 miles north of Victoria, seventy-five miles west of Nanaimo and twenty miles north of Alberni. The park can be reached from the south by way of the Nanaimo-Alberni Railway from Alberni, or from the north by way of Campbell River, which is reached by the island highway northwest of Nanaimo.

Although little is yet known of much of the park, each season is bringing it before the public, and showing that this reservation is worthy of being ranked as equally wonderful in the works of nature as other parks referred to above, which are situated far inland and in lofty mountain ranges.

The contrast is very sharp between lake and stream with their low shores fringed with magnificent and luxuriant foliage and the rugged mountain peaks, often snow-covered or mooring glaciers and snowfield, enclosing waterfalls and noisy cataracts, which resound for a score of miles.

The park is not without its lakes which afford ideal boating and fishing facilities. Buttles Lake affords a picturesque watercourse twenty-five miles long and one to two miles wide, winding down the centre of the park. Streams often with waterfalls enter on either side through heavily timbered shores which terminate in rugged rocky slopes often snow-clad and cold.

Campbell Lake consists of two basins, the lower being seven miles long and one and a half miles wide, while the upper one is about six miles long.

Numerous small lakes which, like the larger ones, are of glacial origin, add charm to the surroundings.

The topography on the whole is rugged

PLATE IX. Berg Lake and Robson Glacier, one of the many beauty spots in Mount Robson Park. Continuous movement in this glacier especially in the summer is evidenced by the cracking and groaning sounds which it makes. The white specks are icebergs which can be seen in the process of formation.

since the altitude ranges from sea-level to nearly 7,500 feet. Elkhorn peak, about 7,200 feet, is known as the Matterhorn of Strathcona Park.

The flora of the park has been studied by James M. Macoun of the Geological Survey of Canada. He reports having noted at least 350 species of phenogamous plants in the park which are very representative of the whole flora of British Columbia. Mr. Macoun writes "a week spent in Strathcona Park will give the botanist or plant-lover a better idea of the flora of British Columbia than can be obtained elsewhere in the same time." Writing about the coniferous trees of the park he remarks that the "Cedar, Douglas fir, pine and hemlock form as fine an example of Pacific coast primeval forest as can be found in British Columbia." Deciduous trees are rarely found within the park. Shrubs, ferns, berries, grasses, lilies, roses and many other flowering plants are numerous and varied, and offer broad fields of research for the botanist. Until the botany has been more thoroughly and extensively studied "any visitor to the park," writes Mr. Macoun, "may expect to find not only species that have not before been recorded from Vancouver Island but which are new to science."

ARTIFICIAL PATTERN LUMBER

A SUBSTITUTE for wood for pattern work, and other similar uses, may be made by mixing with hot water three parts by volume of starch, one part ground glue, two parts fine resinous sawdust. After the starch and glue has been dissolved by the water add the sawdust, and when the ingredients are thoroughly mixed, heat to 190°F., continuing the heat until the mixture becomes a hard mass. The resulting composition can be machined, sandpapered and varnished the same as wood. Besides offering most of the advantages of wood, it is practically fireproof, and is not affected by atmospheric moisture.

This material has no grain and when finished offers a much smoother surface than wood.

Map Showing the Areas of the Earth Chiefly Affected by Seismic Disturbances. It will be noted that within certain of these areas are the highest mountains of the world—which were uplifted during the most recent of the world's mountain making periods. Certain other areas are also marked by crustal warpings and such lack of equilibrium as to produce more or less frequent earthquakes.

1. Alaska-British Columbia belt. 2. California-Ecuador belt. 3. Peru-Patagonia belt. 4. West Indian area. 5. Bermuda area. 6. Iceland area. 7. North African-Portugal-Ireland area. 8. Alpine-Himalayan area. 9. South Indian-Madagascar region. 10. Malaysian area. 11. Japan-Philippine area. *Popular Science Monthly.*

TRUTH IN PUBLICITY

A CRITICISM OF CARELESS OR INACCURATE STATEMENTS IN PUBLIC HEALTH LITERATURE—HOW THE PUBLIC IS OFTEN MISLED BY INACCURATE PUBLICITY

BY CHARLES V. CHAPIN

The modern world believes in education. The adult citizen as well as the child needs instruction. People are trusting less to legislation and more to education. Organizations as diverse as the New York Central railway and the American Social Hygiene Association are conducting campaigns of publicity. With this educational movement I am in hearty accord. It would appear almost an axiom that the teacher should teach the truth. Yet there are many to whom this does not seem to have occurred. If the tares of error are sown among the wheat they are sure to spring up and many a summer sun will come and go before they wither and die. Science is merely truth systemized. Though a distinguished sanitarian has told us that sanitary science should be tempered by common sense, it was spoken in jest. It is not real science but only the pseudo-science of the amateur which needs to be, not tempered, but thrown out root and branch.

In the past, many errors have been taught by alleged sanitarians and enthusiastic reformers of many kinds. Some of these errors are still intrenched in the minds of the public to plague us and hinder progress. Errors often did, and do, masquerade in the name of science, but they are not her offspring.

In the early days of public health work we copied the errors of our European teachers and added to them. There was little real science. Untested theory, or often pure fantasy, dictated sanitary procedure. Let us turn to the teachings of the seventies and eighties of the last century. The environment was then the field for sanitary effort, not the person. Out of about 800 pages of Parkes' Hygiene, only 27 are devoted to the contagious diseases proper. The soil was in those days thought to be a common source of disease. The foul emanations from the decomposing organic matter were sucked up from cellars by the warm air of the house and carried sickness and death; ergo, if one would live, make the cellars impervious with asphalt. One state official writes,

"There can be no doubt that the ground-air under the village of ——— is seriously contaminated with general filth and specific enteric poison, and that this is liable to pass into any or every house in the village, carrying the seeds of disease with it. The ground air is not only drawn into houses by heat, but with every rise of the sub-soil water it is forcibly expelled from the ground into the houses and the streets. This air comes loaded with polluted moisture and may be either the cause of typhoidal or malarial fevers, or of dysenteries, diarrhœas and consumption."

The supposed danger from cemeteries is well illustrated by answers to an inquiry for opinions sent out to sanitarians. one writes:

"If one thing in sanitary science is better settled than another it is that decomposing human bodies pollute both the air above the ground, the ground itself, and the water that percolates through the ground. Polluted air and poisoned water are certainly detrimental to public health."

Another says:

"I do regard the presence of a cemetery, either large or small, in a city, as

detrimental—yea, very dangerous—to the public health. I think poison enough may be derived from one human body to contaminate the well water and the air for a long distance under favorable circumstances for its diffusion. I should hesitate much to drink or use the water from a well situated one-half mile from a cemetery, if the intervening soil was gravelly or sandy, unless said water had recently been subjected to a searching chemical examination."

Filth, we were told, was the principal source of disease. In it bred hypothetical germs, or from it arose still more hypothetical gases. The pig pen, the garbage bucket, the trash pile, the manure heap and the privy vault were equally dangerous. How exasperating to us, who appreciate the evidence that only certain kinds of dirt are dangerous, is the persistent error that all dirt is dangerous. Belief in the supreme importance of dirt as a cause of disease persisted long and at the close of the Spanish war Colonel Waring was sent to clean the city of Havana and so exterminate yellow fever. He did clean it but the fever was more virulent than ever and only the real science of Reid and its brilliant application by Gorgas conquered this pest of our tropics. Even the less obtrusive forms of dirt were dangerous. Listen to what one writer says.

"A prominent physician reports the occurrence in the northern part of the state, of twenty-seven cases of severe typhoid fever, some of them fatal, the direct result of the unhealthy influences of a damp and uncleanly cellar."

"To prevent the emission of ground, air or soil moisture from the cellar bottom or sides, the sides must be laid in good hydraulic or asphaltic cement, and the bottom in the same, or in alternate layers of asphaltic cement and felt saturated with bitumen."

"Disease is also sometimes caused by half cleaned or neglected cupboards, closets, pantries, or provision rooms, where bits and crumbs are left to decay."

"It is not necessary, however, that contaminated water, or the effluvia of surface or pooled filth, or uncleanly cellars or pantries, should be sufficiently poisonous, to produce directly and obviously the common diseases of summer, to be sources of danger; for other derangements of the human economy, varying with the constitutional peculiarities of individuals, may be as easily induced by the same causes; and in absence of any or all acute diseases, it is quite probable that very many of the obscure ailments of numerous persons, not immediately dangerous, have the same origin, and are consequently so perpetuated; making the victim's life almost intolerable with aches and pains, and functional disturbances of the nervous system, the stomach, bowels, kidneys and other organs almost endless."

"The great, the indispensable remedy is cleanliness, and not only of inanimate but of animate bodies also, for filth is the same disease-producing agent, whether upon the surface of the earth, or in or about the habitations of man, or incrusted upon the surface of human bodies."

A dead human body was long considered a great menace. Dead from contagious disease it might cause an outbreak. This theory gave rise to burdensome restrictions as to transportation and funerals which no one, now that we have taken pains to study the subject, would ever think of enacting. The mind of the sanitarian was obsessed with the idea that dead things are more dangerous because of contagion than are the living, hence the fear of fomites and the worship of disinfection, though no one seems to have made even an effort to find out whether disinfection is really necessary.

Air was the chief vehicle of infection, nay, it was infection itself. The emanations from cellars and untidy cupboards which dealt death and destruction through the house have been referred to, as well as the more specific effluvia which gave rise to yellow fever, consumption and diphtheria. Conditions became even more terrible when evidence began to accumulate that living germs, not gases, were the cause of infectious diseases. Listen to what was taught in 1878 in my own state.

"These germs, by their exceeding light-

ness, may separate from any of the emanations from the body, either after having been thrown out upon the surface of the ground, and rising therefrom to be wafted away in the currents of the air, to infect some other person or persons, weeks or months afterwards, and the scores of miles away, or, separating immediately in the sick chamber from the breath, perspiration, scaling off, or other discharge from the body, may rise and floating about in the room, infect some unwary caller, to find lodgment in some nook or crevice, or on some shelf, moulding, sash, ornaments, curtain, drapery or other clothing, to be again dislodged from their resting places, weeks, months or years afterwards, to affect some casual visitor or new occupant, or be carried away in articles of furniture, ornaments or wearing apparel, to spread infection and carry dismay to other persons, and in other localities."

There is little wonder that, when a few years ago we sought to establish a hospital for contagious disease, the neighbors rose as one man to protest against the outrage. Scores of them now spend their Sunday afternoons in our pleasant grounds.

The discovery of vaccination against smallpox was a fine piece of scientific work but it was sadly marred by an assumption entirely unwarranted, that when performed in infancy it will protect through life. After a time this was found not to be true but this mistake more than anything else developed and kept alive the propaganda of the anti-vaccinationist. The opprobrium of our art is that preventive medicine, like its other branches, has taught much that has had to be unlearned. We ought not to be surprised that the people do not believe all we say, and often fail to take us seriously. If their memories were better they would trust us even less.

The methods of science when applied to the problems of life rarely discover the exact truth and the whole truth. Scientific knowledge is a growing plant. New leaves are continuously budding from the old. Rarely does it need pruning and its solid branches shall never be cut away. Jenner proved beyond question the protective power of vaccination, a truth which will always stand, but it remained for others to determine how universal is this immunity and how long it persists and countless other secondary truths of great importance which have been, and are, being added to the original truth. It was only the hasty assumption of the hasty philanthropist which had to be unlearned. In our own time, too, the amateur sanitarian and the social reformer and even the public health official are impatient of the slow progress of science and, taking the short and easy road which is paved with guesswork theories and unfounded assumptions, and which leadeth to destruction, they hasten to spread error before the people, which will later hamper the health officer as does now the assumption of Jenner as to the duration of vaccinia immunity, or does the theory of air-borne infection. Let us see what our health officers are teaching today. Are we doing any better than our forbears?

The old heresy about the all importance of dirt, any kind of dirt, in the causation of disease, still persists. If the writers for the weekly or monthly bulletin cannot think of anything else they can always fall back on a new sermon on dirt. Of course we all know that all human excretions are potential of danger and everything which contains our excretions or is smeared with our fresh secretions must be avoided. We know, too, that flies breed in certain kinds of dirt. It is doubtless true, too, that whatever in a general way encourages cleanliness tends to discourage those habits which favor infection. To fight all kinds of dirt instead of limiting attacks to dangerous dirt is misleading and futile. You smiled at the ancient Rhode Island essay on the relation of dirty cupboards to intolerable stomach-ache but is it not as bad to print,

DIRT IS D isgusting
D isfiguring
D evitalizing
D-e-a-d-l-y

"The dirt-rate of a city is a big factor in determining its death-rate."

"A vigorous anti-dirt campaign would

do the city more good than any other kind of an 'anti' campaign of which we are able to conceive—more good morally, physically, healthfully and eventually with respect to its reputation."

Another:

"To clean up the city means to clean out disease."

"Indifference about dirt produces high death-rates from preventable disease."

"Conspicuousness for habits of cleanliness means conspicuousness for good health and a low death-rate."

A picture bulletin shows adjoining yards, one shiftless and dirty, the other lovely with flowers, with the mottoes, "Dirt and disease go hand in hand." "Clean up for health's sake."

The public will thus believe that, when the streets are swept, the rubbish removed from the cellar and yard, the garbage cremated instead of dumped, and the spring housecleaning done, the city's death-rate will be lowered. When they find it is not, they will not believe the next issue of the bulletin which tells them that antitoxin cures diphtheria.

A poster shows "Household weapons against dirt and disease," a broom, shovel, rake, scrub brush, wash tub, bath tub and set basin and other things. The legend runs, "The main line of defense against dirt and disease lies in the home." Are we expected to shovel up bacilli and sweep out spirochetes? Will the wash boiler prevent the baby from catching whooping-cough or measles? The bath tub is inscribed the "cradle of cleanliness." "Bathe often and give the pores a chance to breathe." Here is either a remarkable use of the English language or a remarkable physiological discovery. It will not be disputed, I think, when I say that there is not a bit of evidence to show that it makes the slightest difference to our health (except for the tonic effect of a cold bath) whether we get into a tub once a day or once in three months. The individual drinking glass, the individual towel, and running water for washing the hands, are necessary to prevent infection, but they found no place in this picture bulletin. May we not safely infer that the artist was not a thinking animal?

A recent bulletin has a picture of a crowded lodging house dormitory with the subscription "A breeding place for germs." Pretty discouraging, is it not, for those of us who have been trying to eradicate the superstition of bygone ages?

Another form of dirt which appeals to the publicity man is dust. Now, there is one kind of dust which is dangerous, that is sharp mineral dust, but that is not dirty dust. It is the dust of the street and home that is attacked in the monthly bulletin. A cartoon shows the dust of the street falling on fruit, candy and ice-cream and a little boy in the throes of stomach-ache presumably caused by eating thereof. No evidence has yet been adduced to show that disease ever is spread in this way and much has been adduced to show that it is not. But under the influence of this campaign of publicity, some communities, which feel too poor to furnish free antitoxin, are spending money to keep dust off the ice-cream and bananas. Another bulletin says, "Avoid home dust." It "often causes disease." The fact is that there is so little evidence that street dust and house dust, except perhaps near careless consumptives, is dangerous, that the less we say about the matter the better.

So, too, in the present state of our knowledge of the relation of the air to disease, knowing that the old theory of exhaled poisons has been demolished, that germs rarely float in the air, that we are still in profound ignorance as to the relation of humidity to disease, that most of the supposed effects of foul unventilated rooms have been shown to be due to temperature and odors, is it not better, when our best students of the subject have little to offer but surmises, to refrain from such teaching as,

"Ventilate, you Lobster! Ventilate!"

"Pure air is the best life insurance."

"Get good air and you will get good health."

Another says,

"No one would think of drinking water that had been used for bathing purposes, but many of them go on breathing over and over again air that has been

breathed by themselves and other people; air that is literally saturated with the effete products of respiration, emanations from the skin and filth carried on clothing and in foul mouths."

"People have been educated to refuse to eat from tableware that has not been properly cleansed, but offer no objection to a second-hand atmosphere for breathing purposes."

"They will keep their skin clean with soap and water and then pollute their respiratory tract with a polluted atmosphere."

"Many of these deaths are closely akin to suicide; many others are closely akin to murder. How much longer shall the slaughter go on? Radical changes have been made in the street cars and some of the theatres. Much remains to be done."

"Some of the hotel banquet halls are incubators for grippe, pneumonia and consumption."

All of this is absolutely misleading.

A cartoon shows "Blithesome Mrs. Foul-Air and her Deadly Offspring—several cheerful skeletons labeled "Tuberculosis, Pneumonia, Influenza, Bronchitis, and Colds" and another editor names la grippe, sore throat, catarrh, colds, bronchitis, pneumonia and tuberculosis as due to lack of ventilation. "You can't see," he says, "the insidious enemy that lurks in the fetid atmosphere."

"Not even contaminated water is more dangerous to the human system than the air that is breathed over and over until its life-sustaining properties have been replaced by foul poisons given off by the human system."

While some men are striving to learn the truth, and solve by scientific methods the difficult problems of disease causation, the publicity man, as blithesome as mistress "Foul-Air," spreads broadcast pestilential errors which date back a half a century or more.

While we feel quite certain that the pneumococcus is the chief causative agent of pneumonia, pathologists and epidemiologists are still uncertain as to the relation of all the causative factors. The carrier, partial immunity, auto-infection, contagion predisposing causes, routes of infection, strains of varying virulence, offer countless problems still unsolved. No one knows just how pneumonia is caused—except the publicity man. He says,

'Pneumonia is a dirty house disease; it is developed in illy-ventilated houses, not in the pure air of out-doors as many people believe. You can't contract pneumonia in pure air; you can very easily contract it in impure air."

Another,

"Be careless about the air you breathe and you stand a good chance of being numbered among the 3,000 citizens who, in all likelihood, will fill pneumonia graves within the next five months."

Still another,

"From now until about the middle of April the pneumococcus will get in its deadly work. It flourishes in bad air, whether in workshop, factory, store, school room, home, or street car. The air of a closed house is foul, stagnant and disease breeding."

Again,

"One of the prominent men of the country died several weeks ago of pneumonia. A day or two before his illness developed he attended a banquet, and was exposed to an over-heated, close, polluted atmosphere. Two prominent citizens attended the same banquet and were made ill, but escaped pneumonia One was 'laid up' for ten days, the other for two weeks."

Our food, by the popular writer, has always been considered a source of great danger, and to attack adulterations is to receive the plaudits of the multitude. A city which boasts of having recently put its health department on a scientific basis publishes:

"Pure food is as important to health as pure air. The authorities, to whom is committed the duty of protecting public health, have a serious responsibility to discharge at this point. They must rigidly enforce the laws against the sale and offering for sale of decayed and decaying food products, without fear or favor. This we propose to do, but we are charged with destroying some food that is salable at cheap prices. Cheap food may be,

and often is, the most expensive food to buy. The poor must be protected against so-called cheap food, which may be partially decayed and dangerous to health. It never pays to run any risk in the food supply of a city. Our slogan is—"Pure food for ———."

A cartoon shows Death pouring adulterants into soups and sardines while a lovely Red Cross nurse, labeled "Health," is dealing out cans marked P–U–R–E. The truth is that adulteration, except in a few instances, is an economic, not a health problem. As to partially decayed foods we know nothing about their relation to health. While inspection may be demanded on esthetic grounds there is no evidence to show that inspection prevents disease. The clean handling of foods is most desirable from a sanitary standpoint but real cleanliness is most difficult of attainment. Much that appears is carelessly written and the emphasis is placed on the wrong thing, as when dust absorbs all the attention and nothing is said about dirty hands. Exaggeration has its way as when we are told that "Dirty ice-cream is a big factor in summer diseases." It is safe to say that the writer neither knows nor cares whether this is true or not.

Some remarkable physiological principles are at times published.

"Lost—One perfectly good pair of kidneys somewhere between Comfort Street and Affluence Boulevard stations on the Road to Wealth. Will gladly pay all my millions for their return.—Mr. I. M. Sorry-Now, 13 Experience Place."

Is it not a comfort to know that the etiology of chronic nephritis has been so well worked out?

Here, too, is news about immunity. If true we may as well give up our vaccine laboratories.

"When we lead a healthy normal life, breathing good air, exercising enough to make a keen blood circulation, eliminating properly and eating our food with a zest, we are at a high point of immunity. Then it is that certain substances within the body make charges against the poisons or toxins and also kill the germs that are responsible for the toxins."

While I have questioned some of the allegations which have been made against the house-fly as a bearer of disease, I am perfectly willing to admit that he does at times and in places become a factor of importance in the spread of fecal-borne diseases. He is also a very dirty and disgusting insect. This is enough. Why call the fly "deadlier than the tiger or cobra" or "the most dangerous animal in the world?" It is news to most of us that "Napoleon could not retain his hold on Egypt because of the fly," and "that many diseases of obscure origin doubtless were caused by fly contamination." The same bulletin says that,

"An eminent medical authority has recently figured out that the fly as a carrier of the germs of typhoid fever annually costs the people of the United States for sickness, medical expenses, lost time and funeral expenses the enormous sum of three hundred and fifty millions of dollars!"

We ought to make this accurate mathematical gentleman chairman of our section on vital statistics.

The following, while interesting reading is somewhat misleading in its etiology.

THE FLY

"He has his birth in the manure, crawls forth and loiters in the sewer, and, smeared with deadly typhoid germs, he leaves his brother maggot-worms, unfurls his dainty wings of silk and dumps his microbes in the milk, where their huge numbers mount and mount, increasing the bacterial count, until they reach the food supply some woman feeds her 'baby-bye.' The fly comes gaily unto us, his feet all gummed with poison-pus, and singing clear his song so sweet, alights and cleans them on the meat. He gathers scarlet fever spores and leaves them on the walls and floors: he is not proud, and oft will stoop to carry heavy loads of croup, and place it where its awful death may come and go with baby's breath. Oh, do not call him indolent! He calls that summer day misspent in which he fails to load the breeze with the live germs of some disease; and if he finds them not, though hurt, he'll be content with just plain dirt."

We would all like to get rid of the fly, but do we really know any practical way of doing it? Is there a flyless city? The bulletins are free with advice, but how good is it? One cartoon purporting to show "How typhoid flies are made" gives mutton chops as their only breeding place. The chief emphasis is usually laid on swatting the fly. This must be practiced on the hibernating insect. To kill one is to kill 350,000,000. Prizes for dead flies, fly traps, poison, and all sort of schemes for handling stable manure are taught us over and over again in infinite variety. Why not wait until some one finds out whether they will work before telling the people that they will work.

One great trouble with the publicity man is an inordinate desire to get in on the ground floor. When he hears something new he tells it without waiting to learn whether it is true. Untried schemes of all kinds are put forward as confidently as if they were as sure as vaccination. It is not so very long ago that the sanatorium was preached as the most important factor in fighting tuberculosis while now many specialists think quite otherwise. Many prophesied the speedy eradication of the disease and not a few fixed the year as 1915. Great speed will be required to finish the last lap. Let us take warning and ever bear in mind that only an exact science can forecast the future. Within a few years various plans of excreta disposal for the rural districts have been published in health bulletins as solving the problem. The editors could not wait to try them. Now they have all proved disappointing and of far from general application. I was recently shown a scheme for the disposal of house drainage about to be published by a state board of health, and when I asked if it had proved satisfactory was told that it had not as yet been tried. Better be the last city to publish a useful sanitary measure than be the first to teach one that later proves a failure.

Many other remarkable things about disease we learn from the weekly bulletins. Thus we read,

"One of our school teachers whose little brothers had died of croup contracted from wet feet some years before, very carefully inspected the little tots in her room for wet feet and found quite a number."

We have plenty of arguments for preserving the teeth without making such a statement as "The use of alcohol to excess does not cause as much disease as neglected teeth." The prohibitionists might well demand the proof.

One bulletin unique in its scientific accuracy yet makes the slip that,

"Every cold in the head . . . comes from a transfer of excreta." Unfortunately we know very little about the group of afflictions called colds and I am not aware that a single type has been definitely proved to be caused by a specific bacterium. On the other hand we do know that one important kind is produced by the pollen of plants and is not contagious.

Probably there are few who agree with me entirely as to the value of terminal disinfection, but I am sure there are fewer still who would assent to the following recent publication.

"Properly and efficiently done, fumigation is a great factor in the prevention of contagious diseases. It is the only means of checking its spread. A number of cities have spent thousands of dollars to stamp out epidemics in this manner. In fact, it is the only way in which this can be accomplished."

Another bulletin, after recommending the burning of a pound of sulphur in each room at spring housecleaning time, says this is, "a simple method of home disinfection that is most thorough and far-reaching in its results as regards disease prevention. . . .

"This simple method is given in the belief that every housekeeper will use it to the extent that all sleeping apartments, closets where clothes are kept, and such other rooms as require fumigation at housecleaning time will be fumigated in this manner to prevent contagious and infectious diseases from entering the home."

Doubtless there are some who will think all this hypercriticism. The slips are small, they say, and seldom occur. It is

true that one may scour many pages of some publications without finding anything to offend, but others show them in nearly every issue. Some, perhaps, are of little moment but who would be so rash as to say that because a lie is a little one it can do no harm. As no one can follow the flight of an arrow, so the poet tells us, or know into whose heart the spoken word shall sink, so no one knows whose mind will be confused by the error which carelessly flows from our pens. One cannot expect scientific accuracy in publicity, a very good friend, who is a forceful writer of telling articles, said to me. I made no decided answer then, but the more I think of it, the more decided I am, that scientific accuracy should be insisted on. Our science itself is so inexact that we cannot afford to swerve one hair's breadth from it. One can hold steadfast to scientific truth and yet avoid, absolutely, all pedantry and scientific jargon. Clear, forceful and catchy writing is worse than useless if it fails to teach the truth and the truth only. So far as it departs from this our health literature approaches that of the fake medicine factory—and perhaps does more harm. The space writer is the curse of our day and generation and especially in our business.

For the sake of those who come after, stop filling your columns with tommy-rot, hot air and dope. Do not be always seeking novelty. Most that is new is bad. There are plenty of old truths which all of our 100,000,000 people have not yet learned. If you have nothing to write do not write it. Remember that bulletins were made for man and not man for bulletins.

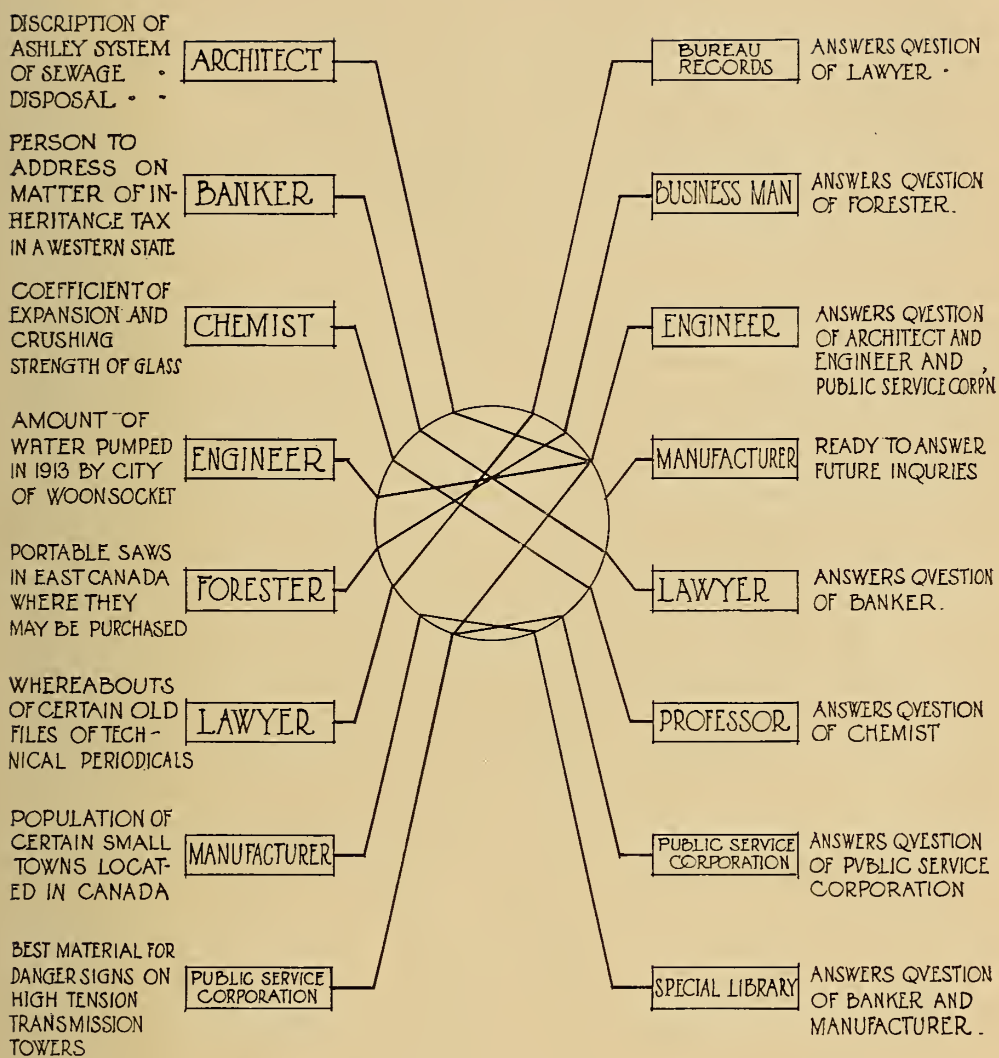
Better pay your publicity man for doing nothing than for writing something which is not so. Careless writing betokens the lazy writer. Seek diligently the truth and faithfully publish it.

THE MISSION OF THE GULL

In an article on the "Value of Birds to Man," published in the report of the Smithsonian Institution, James Buckland of London says: "The presence of the gull is essential to man's health. While the bird fulfills many useful offices—such as destroying larvæ in land along the seaboard and in eating enemies of fish that are exposed during low tide—its chief function in the economy of nature is that of scavenger of the harbors and of the littoral, just as vultures are the scavengers of the mainland. The wholesale destruction of gulls for their plumage in Yucatan was followed by a great increase of human mortality among the inhabitants of the coast, which mortality was irrefutably due to the loss of the birds that had kept the harbors and bays free from the decaying matter which the sea is constantly casting ashore."

MOUNT WILSON OBSERVATORY

No portion of the funds of the Carnegie Institution of Washington has been more fruitfully applied than that which created and has maintained the Mount Wilson Solar Observatory, in California. As Professor Hale, the director of the observatory, says in his last annual report, he and his colleagues have heretofore devoted a large share of their time to devising and testing methods and apparatus, and these are now being applied to solar investigations which were formerly studied with altogether inadequate means. In a forthcoming book, "Ten Years' Work of a Mountain Observatory," Professor Hale will outline the results attained during the first decade of experiments and observations. During the year 1914, which began a second decade, many noteworthy results were achieved. A beginning was made in the application to solar phenomena of Stark's capital discovery of the effect of an electric field on radiation. In stellar astronomy discoveries have been made which promise to furnish the means of determining a star's distance simply by measuring its brightness and the relative intensities of certain lines in its spectrum. Spectroscopic studies in the splendid laboratory attached to the observatory have shed new light on astrophysical problems. The report above mentioned enumerates no less than fifty-nine definite achievements as the fruit of a single year's work.—*Scientific American*.



A BUREAU OF INFORMATION

There is an organization in Boston, which is perhaps the only one of its kind in the country, whose business it is to supply general information to its subscribers, oftentimes within a few minutes after the query has been received.

It is not to be understood that this bureau goes into questions of a fundamental or technical character relating to processes, etc., but it does at least aim to put the questioner in touch with the expert best fitted to give the desired information.

As indicated by its name, the Boston Coöperative Information Bureau, it has immense resources of information among its members who cover a broad field of endeavor. The spread of questions received by the bureau covers almost every subject conceivable, but perhaps the greater number of them have reference to articles in publications, both foreign and domestic.

The chart shown on this page gives something of an idea of how the bureau operates.

LIQUID AIR AND ITS PROPERTIES

SOME REMARKABLE EXPERIMENTS WITH LIQUID AIR, WHICH, ALTHOUGH POWERFUL AS A PRIME MOVER, HAS FEW APPLICATIONS IN THE PRACTICAL ARTS

In his book "The Triumphs and Wonders of Modern Chemistry," Mr. Geoffrey Martin gives an instructive description of liquid air. "Our grandfathers," he says, "would have been much astonished if they had been told in early youth that they would live to see the invisible air in which they lived reduced to clear sparkling liquid which boils on ice, freezes pure alcohol, and burns steel like tissue paper. They would perhaps have been even more astonished if they had been told that in their time men would even succeed in freezing the air, in turning it into a white solid ice-like mass, so intensely cold that its touch burns like the fiercest fire. We propose to lay before the reader a brief account of the magnificent modern researches which have led to these wonderful results."

"To produce liquid air in the laboratory," says Dewar, "is a feat analogous to the production of liquid water starting from steam at a white heat, and working with all the implements and surroundings at the same high temperature. The problem is not so much how to produce intense cold as to save it when produced from being immediately levelled up by the relatively superheated surroundings." After a century of continual effort human perseverance and endeavor have at last succeeded in overcoming these difficulties with the result that liquid air may now not only be produced in gallons at a time, but it may be kept for weeks in wonderful heat impervious vessels first introduced into general use by Dewar.

The problem of keeping this liquid air when obtained was a very serious one. It is similar to the problem of keeping water from boiling away when surrounded on all sides by a white hot furnace. Dewar solved the difficulty by placing it in a doubly walled vessel, the space between whose walls had been previously carefully evacuated. The empty space forms an almost perfect insulation and in such vessels liquid air may be kept for weeks at a time. It may even be transported in such vessels for thousands of miles with but little loss, although surrounding the liquid air on all sides is a medium almost red hot in comparison to it. Think, too, of the curious possibilities that the invention of these heat impervious "Dewar Flasks" opens out. Centuries hence, when the world's supply of coal is almost exhausted, and firing has become immensely dearer, such vacuum-jacketed vessels may come into general use for keeping liquids hot or cold, and even for making the walls of houses impervious to heat or cold. Instead of making hot tea several times a day, the family may in future times make it, perhaps, once or twice a month, and store the hot fluid in one of these vessels and serve it out boiling hot from day to day as required.

Liquid air is nearly as heavy as water and quite as clear and limpid. When seen in the open air it is always muffled in a dense white mist that wells up over the edge of the vessel in which it stands, and rolls along the floor in beautiful billowy clouds. It presents, in fact, much the same appearance as a mass of boiling steaming water. The intense cold of the liquid causes the moisture in the surrounding air to condense as clouds, and it is this which gives rise to the curious phenomenon.

No other substance in the world, excepting liquid hydrogen and liquid helium,

is as cold as liquid air; and yet the hand may be dipped into it fearlessly. The sensation is only that of a soft cushion about the hand. Such it really is. The hand is so hot in respect to liquid air that a layer of vapor surrounds it and prevents the liquid from coming into actual contact with the flesh. However, the hand must not be allowed to remain in the liquid for more than an instant, for if the liquid were actually to touch the flesh a severe injury like a burn would result which sometimes takes months to heal. Even a few drops retained on a man's hand will sear like a white-hot iron. For this reason liquid air has been used in surgical cases where cauterization is necessary. It is stated to eat out diseased flesh quickly and rapidly. Indeed a well-known New York physician seared out a cancer by its means and entirely cured a difficult case. The early hopes entertained of its use in this direction do not, however, seem to have been realized. It is curious to note that over two hundred years ago, the burning effect of great cold revealed itself clearly to Milton's poetic imagination. In his "Paradise Lost" he thus grandly describes the Land of Absolute Zero;

"A frozen continent
Lies dark and wild, set with perpetual storms
Of whirlwind, and dire hail which on firm land
Thaws not; but gathers heap, and ruins seem
Of ancient pile: all else deep snow and ice. . . . The parching air
Burns frore, and cold performs the effect of fire."

The grandest poetic and scientific imaginations are closely akin, and consequently, whatever science may unveil, the chances are that in the world's best poetry will be found hints of every discovery.

The intense cold of this strange fluid may be illustrated by a number of remarkable experiments. Thus melting ice, cold as it seems to us, is actually 180° C. above the temperature of liquid air. It is consequently as hot in respect to it as fat frying in a saucepan is in respect to our bodies, or as molten lead is hot in respect to boiling water. If, therefore, liquid air be poured upon ice it will fly off hissing like water from red hot iron. If some liquid air be placed in a metal tea-kettle and then set upon a block of ice, the air at once begins to boil violently, and a white vapor as of steam rushes from the spout and lid. If the kettle be placed over a fire of burning coals the heat of the fire causes the liquid to evaporate more rapidly and a stream of vapor shoots out of the spout to a great height. It looks like steam from a kettle of boiling water. If water be placed in the kettle as soon as the air has boiled away, it may be taken out as ice, while at the same time the bottom of the kettle will be found coated with solid carbonic acid and ice, frozen from the fire. And all this happens with the fire glowing only an inch or so below. It is very surprising, too, to see one's breath, blown into an open can of liquid air, sent back instantly with its moisture congealed into a miniature snowstorm. Even a jet of scalding steam is instantly frozen, for between steam and liquid air lies an abrupt temperature drop of nearly 300° C. Mercury is instantly frozen into a solid shining metal like silver. This solid metal is as hard as granite, and can be cast into swords and tools. Thus, if a little pasteboard box be made in the shape of a hammer head and filled with mercury, and, after suspending in it a wooden rod to serve as a handle, if the whole be immersed in liquid air, in a few minutes the mercury will be frozen so solid as to form a veritable hammer which can be used for driving nails into hard wood.

Such experiments as these bring forcibly before the mind the abyss of cold which reigns in space about us. By contemplating the intense coldness of liquid air—itself a hot body in comparison to the cold of space—we are enabled to realize clearly how exceedingly hot the world's surface would appear to a being dwelling in the cold and darkness of the waste regions of the universe. Such a being landing on the surface of

our planet would be shrivelled up like a piece of meat in an oven. If he managed to escape in time back to his cold gloomy abode, he would doubtless, like Mr. Wallace, sit down and write a book proving conclusively that no living beings could possibly exist on such a scorching world as the earth.

We must remember, too, that the earth's surface, like every other hot body, is radiating away heat and light into space, only our eyes are not sensitive to perceive it. In Le Bon's words: "Down to the absolute zero of temperature all bodies incessantly radiate waves of light invisible to our eyes, but probably perceptible by the animals called nocturnal and capable of finding their way in the dark. To them, the body of a living being, whose temperature is about 37° C., ought to be surrounded by a luminous halo, which the want of sensitiveness of our eyes alone prevents our discerning. There do not exist in nature, in reality, any dark bodies, but only imperfect eyes. All bodies whatever are a constant source of visible or invisible radiations, which, whether of one kind or the other, are always radiations of light."

Air is liquid at −180° C., and as we have seen, if we raise its temperature above this, it will boil just as water does when heated above 100° C. Steam, in fact, bears the same relation to water that ordinary air bears to liquid air. Since the earth's surface is nearly 200° C. above the temperature at which liquid air boils, it acts in the same way towards this fluid as a coal fire acts towards water. Hence we have only to expose liquid air to the heat of the furnace about us and in which we live, and it boils instantly, producing, like water surrounded by a fire, a vapor which expands and produces power. We can therefore use liquid air as a motive power.

The pressure exerted by liquid air in regaining its gaseous state is simply enormous. Hardly any closed vessel could withstand it. This becomes easily intelligible when we consider that a single cubic foot of liquid air contains condensed within it about 750 cubic feet of air at ordinary pressures and temperatures. If, therefore, it be left to absorb heat from the surrounding air it will expand by this amount, and, if prevented from so doing by being confined in a closed vessel, it will exert a pressure at ordinary temperature of over 10,000 lbs. (four and a half tons) on the square inch. If heated the pressure would amount to from ten to thirty and more tons on the square inch. No ordinary boiler could resist such gigantic pressures. Yet one can realize easily that if this force could be confined and controlled it would give rise to an immense amount of power. It has indeed been suggested that liquid air could be used for driving high-speed engines, for flying machines and other purposes where great power combined with lightness is essential. The great obstacle to its use, however, is the freezing effect it produces. The moisture of the air is rapidly deposited as ice upon the machine, especially round the orifice from which the jet of extremely cold air emerges. This soon closes the exit-tube and stops the machine. There are other disadvantages, too, which cannot be discussed here. The expansive power of liquid air may be demonstrated easily by pouring a little into a tightly plugged steel barrel. In a short time the plug will be expelled with a loud detonation, and sent whirling for hundreds of feet into the air. Some liquid air poured into stout steel or copper tubes which are then firmly sealed will in a short time cause them to explode like shells, sending the metallic fragments hurtling in all directions with great force.

Although liquid air is as harmless as water, and so long as it is not confined, cannot of itself explode, yet it is an extraordinary fact that, when mixed with other substances, it can form an explosive comparable in intensity to dynamite itself. Thus, in some experiments carried out by Mr. Trippler of New York, a bit of oily cotton waste, soaked in liquid air, was placed inside an iron tube open at both ends. This was laid inside a larger and stronger tube, also open at both ends. When the waste was ignited by a detonating fuse the explosion was so

terrific that it not only blew the smaller tube to pieces, but it burst a great hole in the outer one as well.

Indeed in Germany practical use has been made of this fact in blasting in coal mines. Cotton wool impregnated with coal dust and steeped in liquid air is rammed into a hole drilled in the coal, and the whole exploded by a detonator in the ordinary way. The explosion which ensues is as effective as a dynamite one, but without its risks; for should a charge fail to explode in a few minutes all danger is past; because there remains only cotton and coal dust when the liquid air has evaporated. This is a valuable feature of its use, since many lives are lost annually in attempting to remove dynamite charges which have for some reason or other failed to explode.

This property of liquid air is due to the fact that it contains oxygen in a very concentrated form. When it is mixed with a substance which will burn rapidly in oxygen, and a detonator is applied to the mixture, an explosively rapid combustion sets in, in which the sudden intense heat generated causes an instantaneous and violent rush of gas so that the whole goes off like so much dynamite. Indeed the actions in both cases are much the same, as we shall see when we come to deal with the latter body.

As we have already pointed out, air is composed of twenty-one parts of oxygen and seventy-nine parts of nitrogen. It begins to boil at $-195°$ C., the boiling point of nitrogen. The nitrogen boils off first, leaving behind the oxygen, and so the temperature gradually rises until it reaches $-183°$ C.

The more nitrogen it loses, the bluer and at the same time the heavier the liquid becomes. This change may be shown easily by pouring a quantity of liquid air into a large glass bottle partially filled with water. For a moment it floats, boiling with great violence, liquid air being slightly lighter than water. When, however, the nitrogen has all boiled away, the liquid oxygen, being heavier than water, sinks in beautiful silvery bubbles, which boil violently until they disappear. A few drops of liquid air thrown into water will instantly freeze for themselves little boats of ice, which sail around merrily until the liquid air boils away. In this way ordinary liquid air exposed to the atmosphere becomes very rich in oxygen, and oxygen in such a concentrated form is a very wonderful substance. For instance, ordinary woollen felt can hardly be persuaded to burn even in a hot fire; but if it be dipped in this liquid oxygen, or even in liquid air, it will burn fiercely with all the terrible violence of gun-cotton. A splinter of wood, when soaked in liquid air rich in oxygen, will burn like a fiery torch with immense power, while a glowing wood splinter plunged into liquid air bursts into furious flame, and may cause the whole vessel containing the liquid air to be shattered by the heat developed. Indeed, steel itself may be burnt by liquid air. To demonstrate this a tumbler of ice is made, and it is half filled with liquid oxygen. A burning match is then attached to a bit of steel spring and the whole dipped into the liquid air contained in the ice tumbler. The steel then burns, spluttering and giving out a glare of dazzling brilliancy. Between the liquid oxygen and the burning steel are about 2,000° C., and yet the ice tumbler is not affected. The oxygen is turned into a gas before combustion begins. For liquid oxygen itself probably will not support combustion. Instead of a steel spring, an electric-light carbon red-hot at its tip will burn in exactly the same way with dazzling brilliancy. Thus the abyss of cold which prevails in liquid air does not prevent it from acting as a powerful inflaming medium.

Liquid air introduces us to a strange cold world very different from the one in which we live. All things alter their properties to an astonishing extent at these low temperatures, and the exploration of the properties of matter under these new conditions is now steadily proceeding in all parts of the civilized world. Thus iron and steel increase their tensile strength immensely, but at the same time become as brittle as glass.

WOOD PRESERVATION

Investigations on the effect of zinc chloride as a preservative for the cheaper grades of pine for structural purposes have been made by Alfred Henry Clarke of the Institute of Technology and made the subject of his graduation thesis.

The usual means of prevention is by filling the wood with a poison such as zinc chloride which is found easy of application and efficient as a preventive of rot. It has been suspected, however, that the use of zinc chloride might, in itself, impair the strength of the timber, and Mr. Clarke's research has shown that wood thus treated and kept at a temperature of 150°F. for forty days possessed about 38 per cent. of the breaking strain of untreated specimens. It often happens in factories that wood is kept at quite a high temperature for a considerable time, and under such circumstances the use of zinc chloride would have a weakening effect. These studies suggest the need of further investigation along this line.

COLOR BLINDNESS

It is only within a hundred years that color blindness has been known to exist, and it is only comparatively recently that it has been known that women are never color-blind. Color blindness is a characteristic which is inherited and passes on from one generation to another. If all the children of a color-blind father are girls, the trait remains dormant and reappears in one of every four male children of the next generation. It is, therefore, a sex link characteristic.

There are two types of complete color blindness, each of which has to do with two groups of colors—red to blue and white and black. When the color-blind man has two important colors affected, he is said to be "dichromatic." When he is only color-blind and sees merely white and black, he is "monochromatic."

In the first of the above divisions are those who are red blind, green blind and violet blind. Red blindness is most frequent. Its victims are really blind to both green and red, distinguishing only yellows and blues.

The seat of color vision is at the very center of the retina. If the retina were painted with rings like a target, the bulls-eye would contain the visual points for green, the next outer ring would be red, the third, blue, then white, and the outside ring would be black.

Some persons see colors imperfectly, but do not have true color blindness. This defect is due to the use of tobacco. There is no known way of curing color blindness.

Science Conspectus

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VOL. V 1915 No. 1

The Aim of Science Conspectus

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It is the aim of SCIENCE CONSPECTUS to give a general survey of the field of science and its applications in such a way that every article will have some educational value for every reader. We shall strive to describe the most important current developments in the field of scientific activity in terms within the understanding of the intelligent lay reader, and in general we shall confine these descriptions to reasonable limits, often to the extent of brevity. We shall not attempt to preserve a balance in the amount of material presented between various branches of science. Most of the articles will be original material from authorities in their special lines of investigation. The publication staff will, however, make digests and summaries of important articles as they may appear in current publications, and we shall not hesitate to reprint any articles which may be of particular value to our readers. The matter in SCIENCE CONSPECTUS will not be printed simply because it is available, but will be carefully selected, and wherever possible will be amply illustrated.

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